Pit and Quarry

Published Every Other Wednesday for Producers and Manufacturers of Sand, Gravel, Stone, Cement, Gypsum, Lime and Other Non-Metallic Minerals.

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Vol. 16 CHICAGO, ILL., MAY 9, 1928 No. 3

AN IMPORTANT LIME CONVENTION

LIME manufacturers should take particular notice of the annual convention of the National Lime Association called for May 23rd and 24th at the Belmont Hotel in New York ity. This convention has been deliberately arranged as an informal affair so that any lime manufacturer can attend with assurance that the meeting will be open in the fullest sense. In fact, this will be a convention of the industry and not of the Association. Knowing, as we do, what is hoped for by this convention, we earnestly recommend that every lime manufacturer be represented at this convention. Much can be accomplished this year but this largely depends upon a large attendance.

The convention will get underway with a luncheon at the Belmont Hotel on May 23rd. Some outstanding individual will give the keynote address at this luncheon. A business session will follow this luncheon and then a Round Table Discussion of practical problems confronting the lime industry will be conducted. A dinner with entertainment furnished by the Valve Bag Company will be held in the evening.

The meeting on Thursday will begin with an address entitled "A Million Times Nothing," by Charles F. Abbott, Executive Director of the American Institute of Steel Construction. After the address, the Round Table Discussion will be resumed and carried through until adjournment.

NEW IDEAS

LESS than 100 years ago the school board of Lancaster, Ohio, indignantly refused the use of their school house for a meeting to discuss whether railroads were practical; stating as a basis for their refusal, that "such things as railroads are impossibilities and rank infidelities."

Back in 1834 when the steam locomotive was in its embryonic stage, there existed the prevalent notion among locomotive builders and railroad men that locomotives could not run uphill. Whenever a train came to a hill, the locomotive was unhooked, the cars pulled up by a winch, and a new locomotive attached at the top of the incline. While this seems ridiculous now, no one seemed to think it strange at that time. One day a Mr. Morris, a rival of the original Baldwin, decided to actually try running a steam locomotive uphill and to his immense surprise, it got along quite well. When he told of this fact, nobody would believe it. Even when the editor of the Railway Journal recounted his wonderful experience of having been pulled uphill, an indignant subscriber wrote in that the editor had joined the ranks of liars—that the thing couldn't be done—that it was in violation of the law of gravity—then proceeded conclusively to prove by algebra that such a thing was impossible.

When the first steam boat plowed its sluggish way up the Hudson River, Fulton was regarded as a modern incarnation of Lucifer. When it was known that the fire was used to heat the water and thereby generate steam, worthy ecclesiastes debated the question publicly as to whether man had the right to make fire and water work together when God had definitely put them asunder. Man, they said, had no right to unite what the Supreme Architect had divorced. Even to the day of Edison —when he assumed the responsibility for the completion of the first central station in New York City, the project was denounced as impractical throughout the scientific world.

We don't have to go back so far, however, to find examples of astonishing opposition to newly developed devices. It took ten years to convince business men of the economy of the typewriter after that machine had reached mechanical practicability. It took nearly 50 years plus our Civil War to persuade people to eat canned foods. The vacuum bottle, invented by an English scientist as a means to convey serum from his laboratory to the royal palace when Queen Victoria lay dying, did not find its way into universal use until years had passed.

Such instances and ones even more illustrative of the reluctance with which human mind was wont to accept anything that might disrupt the even tenor of established ways, could be recited to a point of ad nauseam. Why it seems only a few years ago that neither the railway brotherhoods nor the managements would condone the discard of the old link and pin, with the result that it took an act of Congress to bring about the adoption of

the automatic coupler. But it's different today. We have progressed far along the path leading toward mental and physical acceptance of new ideas and devices.

Perhaps in no better way can our mental progress be proved than by the mere fact that the great majority of American manufacturers and business men take a keen delight in being spoken of as pioneers in their particular line of work. We have come to the point where we know progressivism to be far more valuable than conservatism. Nothing is so desirable as to be considered progressive. And it is fitting that this be so for otherwise our industries would not have attained the heights they now hold.

However, the mere fact that it has taken so long to attain our present industrial eminence augurs well for the future if only because of the lessons our hesitance has taught. Knowing the fallacy of discounting new ideas and refusing the adoption of improved devices, we are no longer content to continue in beaten paths but, each and all, are striving to improve existing conditions and present positions that we may reach still higher and greater achievements. The most clearly defined characteristic of the present era is the refusal of people to be content with things as they are. Additionally, with our complete recognition of the instability of present day methods, machinery and schemes, there are few indeed who will not freely predict strange and better methods for the succeeding generation.

As hurtful as the truth may be there is little to be gained by refusing to recognize the fact that many manufacturers have been more laggard in the alteration of policies and methods, at least in comparison with members of other industries. There doubtless are, of course, reasons for this. The paper industry, for instance, has not been confronted with the same rapid obsolescence of machines and methods that other industries have had to sustain. Industries such as the automotive, transportation, public utility, sugar, printing, or leather have faced problems and rapid changes that were of far greater magnitude and import than ever confronted, let us say, the paper, sand and gravel, ceramic or logging industry. This comparative freedom from upsetting tendencies has left many members of these, and other industries with a hesitance to accept new ideas that were outgrown by members of extraneous industries years ago.

The time is coming when all this must be changed. Nor is that time far advanced. Changes are being effected today that tomorrow will render obsolete our time honored methods and machinery. And the firms who recognize this truth—will keep alive to every change—remain ready to adopt all those changes that are worthy and justified—then alter their administrative policies to fit—will be in a position to merge with other firms—as the dominant party to the transaction. Inversely, the firms who sit tight in their show-me-Missouri position and adhere to obsolete methods in spite of outside pressure will be the ones who will find it impossible to successfully cope with the more progressive competitor.

Several years ago many in the leather industry scoffed at the possibility of tanning and using the skin of sharks and other deep sea undesirables for leather. Today, marine leather is being produced in large quantities. It not only tans to a beautiful hue but in comparison to animal leather is practically indestructible. The pelt from a shark is about two-thirds the size of a full grown steer—and it was raised without expense so far as pasturage or superintendence is concerned.

Heavy metals are giving way to other types that in addition to being lighter in weight are stronger and more lasting. Not long hence we will have 100 horsepower motors that a man can carry on his shoulder. Adding machines and typewriters will weigh only one-tenth their present poundage and rolling stock for railways will be light enough to justify a decrease in freight rates. All this has come about through the study of atom construction and molecular arrangement.

A few years ago only a very few articles were manufactured from the mineral we know as asbestos. Today, this strange rock is being used in the manufacture of phonograph records, switchboards, tapestries, rugs, ladders, brake linings, pipe coverings, mailbags and many other articles.

Invention and development is the order of the day. More than 40,000 patents are granted by our Government every month, and it is becoming absolutely imperative from the standpoint of commercial existence that we keep abreast of these things, among which are developments of deep going importance.

Of course, some of the so-thought, far-reaching developments of today will never gain universal adoption. Indeed, it is well that some of the notions of would-be inventors and originators do not go over with a bang because a lot of contraptions that are supposed to work wonders never get beyond the idea stage. Now and then an utterly unsound device does "get by" temporarily with the result that the number of good, honest people who were led to believe that their certain device was a wonderful achievement will later discover themselves buncoed.

These false alarms and poor starts should not blind us, however, to the fact that among the countless improvements now being developed (many of which are arising from outside sources) there are a large number that likely will prove little short of revolutionary. It is for us to keep alive to all, sift the wheat from the chaff—then plant the wheat.

MEN OF THE INDUSTRY

The portraits printed on this page in each number of PIT and QUARRY are taken from our files and their selection is without significance as to current events or as to the position of the individual in the industry.

H. Dittlinger

Mr. Dittlinger is President of the
Dittlinger Lime Company of New Braunfels
and Houston, Texas

STRUCTURAL GYPSUM

By Henry J. Schweim, Chief Engineer The Gypsum Industries*

DEVELOPMENT in the use of structural gypsum has been a result of the logical sequence of systematic and scientific tests which have been carried on over a period of many years in order to meet the constantly evolving demands of engineering and architectural designs. These demands require that every material used in modern building, from the foundation to the finished roof, shall be efficient for the purpose intended and shall be selected with due consideration given to the particular function it is expected to perform and to its durability, practicability and economy.

To fully appreciate the value of gypsum used for structural or other purposes, it is necessary that the chemical nature of the mineral be kept in mind. The conversion of gypsum to calcined gypsum, plaster of Paris or stucco is through calcination, a process of dehydrating or removing a large part of the chemically combined water.

Gypsum is composed of one part of calcium sulphate and two parts of water, hence its chemical formula is $CaSO_4.2H_2O$. Calcination removes approximately $1\frac{1}{2}$ parts of water, leaving $CaSO_4.\frac{1}{2}H_2O$, which is known as calcined gypsum or plaster of Paris, the basis of all gypsum products.

*Presented at the Fourteenth Annual Meeting of Building Officials Conference of America, Detroit, Michigan, April 24, 1928.

The temperature for calcining first settle gypsum is about 330° F. which temperature is reached in about two hours. When gypsum is being calcined it boils or surges violently in the kettles. This is caused by the steam which is being rapidly given off. When the temperature reaches 320 to 330° F. the material settles down to a quiescent state. If the calcination is stopped at this point, the resulting product is known as "first settle" gypsum. If calcination is continued, the boiling begins again and at a temperature of approximately 400° F. the material settles a second time; the result is "second settle" gypsum, a denser, stronger product and of lower consistency.

Gypsum Used by Ancients

The use of gypsum dates back to ancient times. The Temple of Apollo at Bassae, which was built in 400 B. C., bears witness to the permanent structural qualities of this product. During the time of Pliny the Greeks were users of gypsum. This naturalist (23-79 A. D.) refers to gypsum in his writings of ancient history and describes the removal of a beautiful gypsum plaster frieze to beautify a public building in Rome.

In Volume XXVIII of the Iowa Geological Survey Dr. F. A. Wilder states the following:

Second Settle, Structural Gypsum Load Bearing Wall Tile

"The use of hydraulic gypsum was known to the Romans and this material served them well in many important and enduring structures. Alabaster was highly valued by Greeks and Romans and the ancients in general for vases, ornamentation and the lighter forms of statuary. The Romans esteemed gypsum also as a fertilizer.

"Hydraulic gypsum formed the mortar used in medieval times in the construction of German castles and fortresses. In the vicinity of gypsum quarries, hydraulic gypsum was used exclusively in mortar making. On the southern border of the Hartz, in Thuringia, in Luneberg, Legeburg and elsewhere are found interesting relics of the days of chivalry which are enduring monuments to the worth of gypsum for exterior construction. The beautiful ruins of the monastery at Walkenreed, the ancient cathedral of Bardowiek, the remnants of the walls of Luneberg, Nordhausen and other cities in the Hartz mountains show how gypsum mortar has withstood a trying climate for hundreds of years, and how age has seemed merely to intensify the bond between the gypsum plaster and the stone blocks that compose the ancient structures."

Mining of the Mineral

Gypsum is abundant in Europe, Asia, Australia, Canada, Alaska, South America, and the United States. The term "plaster of Paris," commonly applied to calcined gypsum, owes its origin to the existence of large deposits at Montmartre, which is near Paris. In our country the gypsum products commonly used in building construction are produced from mines and mills located in Arizona, California, Colorado, Iowa, Kansas, Michigan, Montana, Nevada, New Mexico, New York, Ohio, Oklahoma, Oregon, South Dakota, Texas, Utah, Virginia, and Wyoming. The largest producing states are New York, Iowa, Michigan, Ohio, and Texas. Gypsum is obtained also from Alaska and is imported from Manitoba, Nova Scotia, New Brunswick, and Ontario in Canada.

In winning this nonmetallic mineral from nature it is either mined or quarried depending upon the location of the strata with reference to the surface of the earth. The rock is blasted and taken out in sizes that are convenient to handle. It is then loaded in cars and hauled to the mouth of the mine from which the material is hoisted on an incline or in an elevator to the headhouse. From this point, the rock is conveyed to a gyratory crusher which crushes it to three inches or less in size. From the gyratory crusher the material is delivered to a secondary crusher where it is further reduced to three-quarters of an inch in size. The rock is then conveyed to the dryers where the surface moisture is driven off. The next process is the grinding of the rock to the fineness desired by means of buhr stones, Raymond mills, or hammer mills. The ground gypsum is then fed into steel kettles, cylindrical in shape, or rotary calciners. The usual size of kettles is from eight to twelve

Showing Short Span Gypsum Roof Tile

feet in diameter and in depth from eight to ten feet. Kettles of this size hold from eight to fifteen tons of raw material. Calcination requires approximately two hours and the resulting product is known as stucco, plaster of Paris, or calcined gypsum.

Tremendous Growth in Production

The steady growth in the quantity of gypsum mined in this country is evidence that the product is becoming increasingly more important in building construction. Gypsum was discovered in New York State in 1792 and, in 1808, a stock company was formed to quarry and market land plaster. In 1835 gypsum was found in Virginia. In 1840 a gypsum deposit in Grand Rapids, Michigan, was located, and in 1850 one near Sandusky, Ohio, was discovered. The deposits located in Iowa were found in 1872 and those in California in 1875. However, it was not until 1892 that the first calcined gypsum plaster was produced in New York State. In 1895, the tonnage of crude and calcined gypsum amounted to 265,000 tons, which was mined in thirteen states. By 1915, eighteen states and Alaska were producing nearly ten times as much gypsum as was produced in 1895. Since the conclusion of the World War there has been a phenomenal increase in the annual production of gypsum. In 1920, 3,129, 142 tons were mined and by 1925 the annual tonnage produced had risen to 5,678,302 tons, exceeding all previous records. It has been estimated that the production of gypsum for 1927 amounted to about 5,748,000 tons. From these statistics it is seen that the production of gypsum in this country in 1927 was almost twice as much as it was in 1920 and approximately 2,140 per cent greater than in 1895.

Uses in Building Construction

That gypsum has the characteristics necessary for successful use in building construction is indicated by the constantly increasing demand for this product for such purposes. Gypsum is used mainly as a plastering material, in the construction of floors and roofs, for the fireproofing of structural steel, for partitions, for gypsum board products, and as an insulating material. This paper deals for the most part with the use of gypsum as a structural load carrying material.

Drilling Face in Gypsum Mine

Suspension Construction

Gypsum floors and roofs may be either poured-

Showing An Operating Gypsum Quarry

in-place or precast, and of the reinforced suspension system or of slabs or tiles in which the gypsum acts structurally.

Poured gypsum suspension floors and roofs are one of the earliest types of modern fireproof construction, having been used for the last thirty years or more during which time there have been installed many millions of square feet. In this type of installation the design is based on the same principle as that of the suspension bridge and the construction is commonly known as the Metropolitan system. It consists of a monolithic gypsum fiber concrete slab poured-in-place on parallel and uniformly spaced steel cables which are placed in suspension, the ends of the cables being securely and rigidly anchored to the frame of the building. Each cable consists of two number 12 gauge cold drawn, galvanized steel wires which are twisted. The cable spacing depends on the span used and the superimposed load which must be sustained.

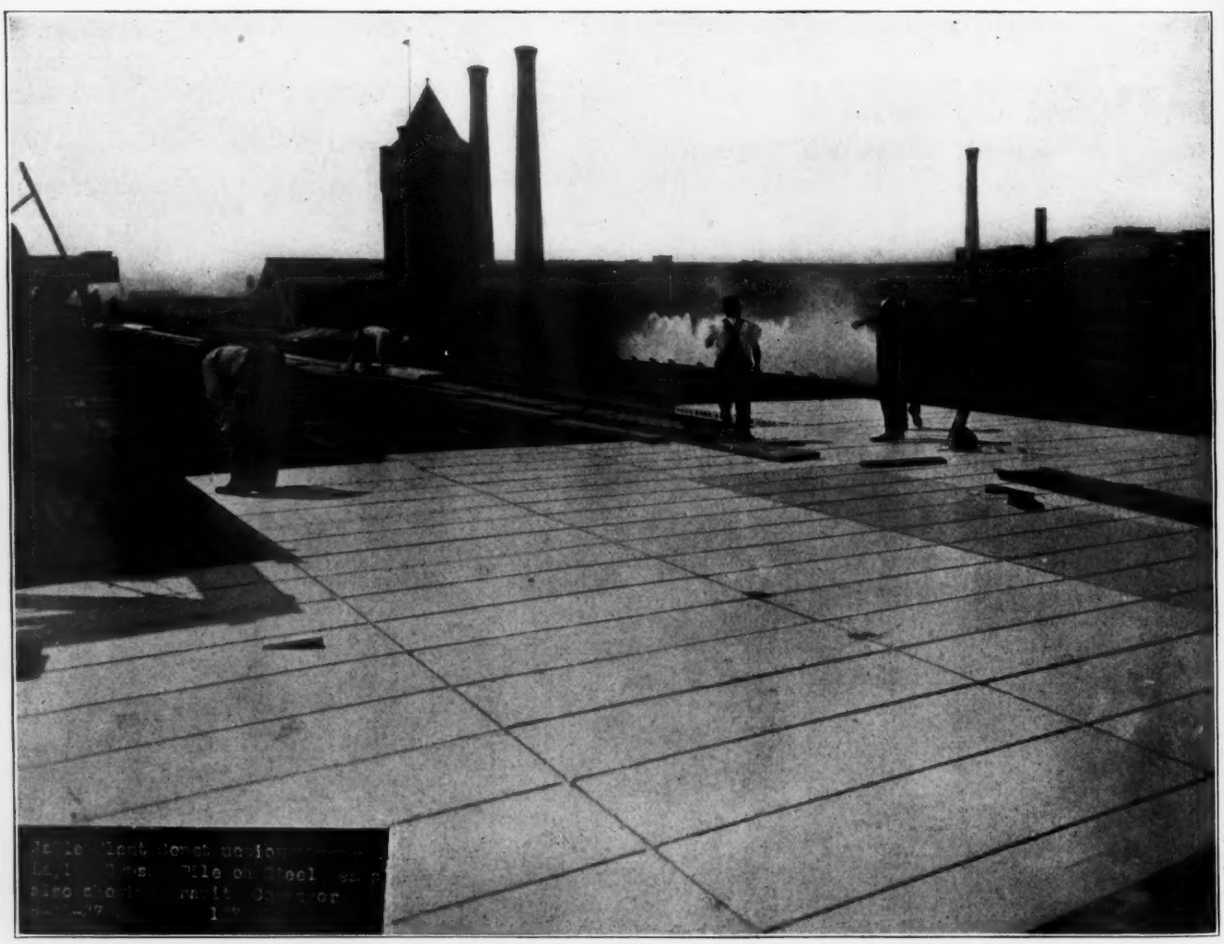
The gypsum fiber concrete is a composition of "first settle" gypsum and not more than 12½ per cent by weight of wood chips, excelsior or fiber. The superimposed loads are transferred to the steel cables through the gypsum slab. The tension in the cables due to the superimposed load is transmitted to the end beam or purlin and the horizontal thrust is taken up by bracing members. The cables are securely anchored at both ends by means of bent strap iron of sufficient strength to resist the maximum pull of the cables. The cables are put in uniform deflection and tension by means of a ⅝ inch round deflection rod. The stress in the suspension wires or cables is determined by the following formula:

$$T = \frac{wL}{8d} \sqrt{L^2 + 16d^2}$$

In this formula "T" is the maximum tension in the cables per foot width of span, "w" is the total load per square foot, "L" is the clear span between supports in feet, and "d" is the deflection or dip of the cables in feet at the center of the span. In the cables a working stress of 20,000 pounds per square inch is used.

The first step in the installation of a poured gypsum suspension floor or roof is the erecting of the forms or centering. This form work is similar to that used in reinforced concrete construction. After the completion of the forming, the steel cables are placed in position and the gypsum fiber concrete is poured-in-place and brought to a uniform surface.

The gypsum fiber concrete used in poured suspension floors and roofs will develop a minimum ultimate compressive strength of 500 pounds per



Laying Long Span Gypsum Roof Tile on Steel Beams

square inch. (References to tests to determine the ultimate strengths of gypsum fiber concrete will be made later in this paper.) As stated previously, the superimposed loads are transferred to the cables through the gypsum slab and the cables are designed to carry the entire load.

Assuming the most adverse conditions of loading, the total design load as determined by the suspension principle does not set up bond, shear, or bearing stresses in excess of those that the gypsum fiber concrete can safely carry with an adequate factor of safety. The ultimate load sustained by each cable as determined by bond, shear, or bearing is always greater than that as determined by the suspension principle.

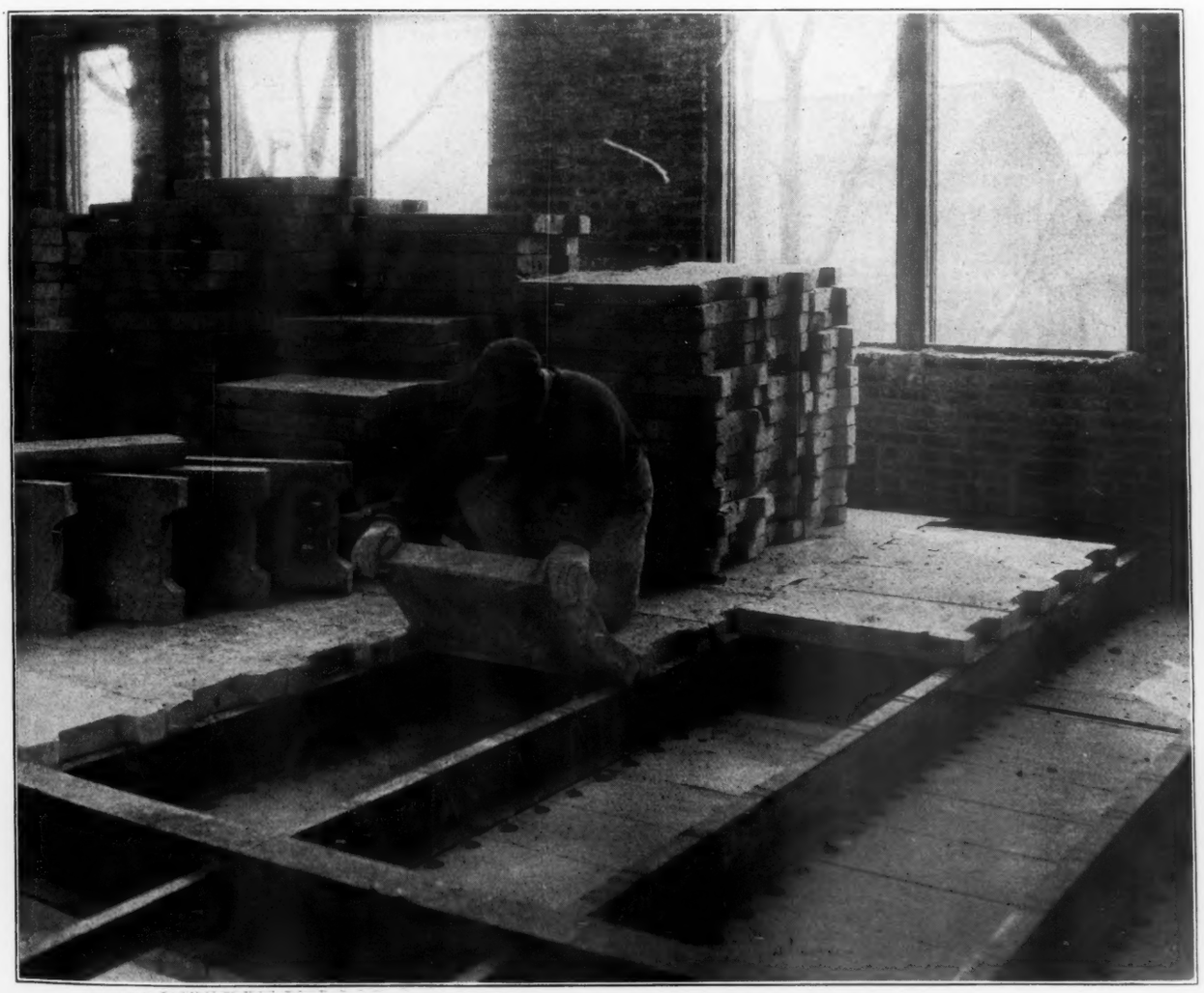
Pre-Cast Structural Units

Pre-cast gypsum roof tile which are manufactured of neat "second settle" gypsum are of the type of construction in which the gypsum acts structurally and have been in successful use since about 1912. In fact, short span roof constructions of reinforced gypsum were popular some years before 1912 but the year referred to marks particularly the development of this type of reinforced structural gypsum to accommodate longer spans. This system differs from the suspension system in that the construction is designed in accordance with the accepted formulae for reinforced concrete as recommended by the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete with the exception, of course, that appropriate working stresses are used. Short span tile of this kind are 30 inches in length. Longer spans, up to and including 6 feet are also used.

Tests By Professor W. A. Slater

The fact that the principles of design in common use for reinforced concrete could be applied to reinforced gypsum was determined as a result of a series of scientific tests conducted under the direction of W. A. Slater, formerly Research Assistant Professor of Applied Mechanics at the University of Illinois. A paper by W. A. Slater and G. P. Anthes, which describes these tests appears in the *Journal of the Western Society of Engineers*, dated September, 1919. From that paper the following is quoted:

"The test of the T-beams indicates that the same principles which are used in the design of reinforced concrete beams are applicable to reinforced gypsum beams."



Laying Structural Gypsum Floor Tile

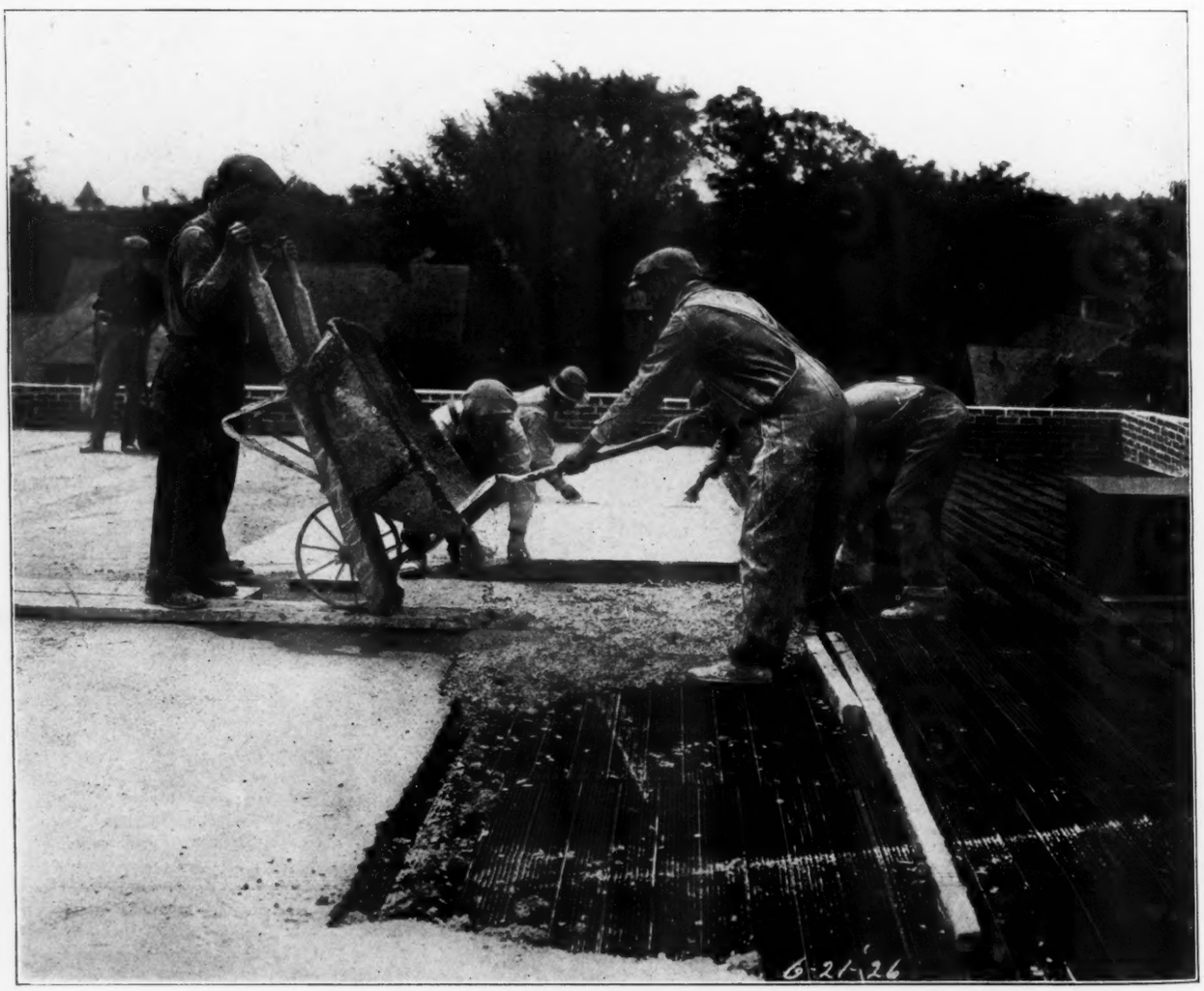
It was from these tests that data were developed which are used as the basis for the working stresses and the values of the constants used in the design of pre-cast structural units in which "second settle" calcined gypsum is used as the cementitious material.

Professor Slater's tests extended over a period of about four years, from 1914 to 1917. The purpose of his 1914 tests was to determine the compressive strength and modulus of elasticity of gypsum. In 1915, information was obtained mainly on the shearing strength of reinforced gypsum beams. In 1916-1917, tests were made which were more comprehensive than either the 1914 or 1915 series and the purpose was to develop additional data concerning the structural properties of gypsum.

Second Settle Gypsum

In the above investigations, values for ultimate compressive strengths were obtained from control cylinders which were made frequently and tested usually at an age of 7 days after storing at 100° F. Some, however, were stored at 70° F. and tested when dry. The control cylinders were made at standard consistency, 0.1 per cent retarder being used in most cases. Some were made from material which was unretarded. The following table gives the ultimate compressive strength of second settle gypsum as determined by these tests:

Specimen Number	Pencentage Gauging Water	Per-centage Moisture	Per-centage Dryness	Compressive Strength in lbs. sq. in.
Dried In Kilns At 100 Degrees Fahrenheit Age At Test Seven Days				
U-4-29- 1 to 3	38	....	102.7	2,400
R-4-29- 1 to 3	38	....	104.0	1,920
U-5- 2- 4 to 6	38	....	99.5	2,680
R-5- 2- 4 to 6	38	....	101.5	2,340
U-5- 5- 7 to 9	37	....	99.5	2,730
R-5- 5- 7 to 9	37	....	99.5	2,440
R-5- 8-10 to 12	37	4.32	98.8	2,380
R-5- 8-13 to 15	37	4.22	103.5	2,240
R-5- 8-16 to 18	38	4.22	102.7	2,450
R-5-15-19 to 21	37	4.98	103.2	2,300
R-5-19-22 to 24	37	3.47	104.5	2,310
R-5-31-25 to 27	37	4.60	103.2	1,930
R-6- 7-28 to 30	37	4.73	102.3	2,070
R-6-10-31 to 33	37	4.35	102.2	2,340
R-6-16-34 to 36	36	4.68	102.5	2,020
R-6-27-37 to 39	36	5.07	94.2	1,940
R-6-29-40 to 42	36	4.91	99.5	2,400
Dried In Laboratory At Room Temperature Age At Test Thirty Days				
R-7-10-43 to 45	35	4.84	105.5	2,020
R-9- 1-46 to 48	34	5.24	99.8	2,460
R-9- 8-49 to 51	34	5.20	109.0	2,300
R-9-25-52 to 54	34	5.20	101.7	2,000
R-10-6-55 to 57	33	4.70	104.0	2,950
R-10-6-58 to 60	33	4.70	104.7	2,650
Average				2,316



Pouring Gypsum Concrete on Ribbed Lath

General notes for all specimens:

Three inch by six inch cylinders of second settle calcined gypsum.

Each figure on compressive strength is an average for three specimens.

"R" denotes a specimen having 0.1 per cent retarder.

"U" denotes a specimen having no retarder.

Concerning the ultimate compressive strength of "second settle" gypsum, Professor Slater, in the summary of his tests, states the following:

"The permanent strength of second settle dry specimens made from gypsum mixed at standard consistency and having 0.1 per cent retarder seemed to be about 1,900 to 2,000 pounds per square inch whether dried at 100° or 70° regardless of the size of the specimen."

In April, 1918, compressive tests on two inch by four inch cylinders of "second settle" gypsum were conducted by the Building Department of the City of Minneapolis. Twelve cylinders were tested with the following results:

Specimen	Ultimate Compressive Strength in Pounds Per Square Inch	Specimen	Ultimate Compressive Strength in Pounds Per Square Inch
CD-1	2,680	CD-7	2,275
CD-2	2,040	CD-8	2,475
CD-3	2,135	CD-9	2,420
CD-4	2,490	CD-10	2,365
CD-5	2,080	CD-11	2,590
CD-6	2,075	CD-12	2,450
	Average—2,340		

The standards of the Gypsum Industries require that hydrated neat gypsum as used in pre-cast tile shall develop a minimum ultimate compressive strength of 1,800 pounds per square inch. The working fiber stress in compression in flexure which is used is 350 pounds per square inch. From this it is seen that there is a factor of safety of not less than 5.1.

One of the constants involved in the design of reinforced gypsum in which the gypsum acts structurally is, of course, the modulus of elasticity. In the 1915 series of investigations, Professor Slater, from tests conducted on cylinders, made determinations of the modulus of elasticity varying from 965,000 pounds per square inch to 1,450,000 pounds per square inch. Further concerning this, the following is quoted from the paper by W. A. Slater and G. P. Anthes, read before the Western Society of Engineers:

"The difference between the stress-strain curve for a dry specimen (tested at 110 days) and one tested at 10 days is brought out in Fig. 4. The dry specimens show a modulus of elasticity of somewhat more than 1,000,000 pounds per square inch and the ten-day specimens having not more than 35 per cent of water show a modulus of around 750,000 pounds per square inch. In Fig. 34 the secant-moduli of elasticity for specimens varying in percentage of dryness have been plotted for various loads. It will be seen that for the dry specimens the modulus of elasticity was nearly

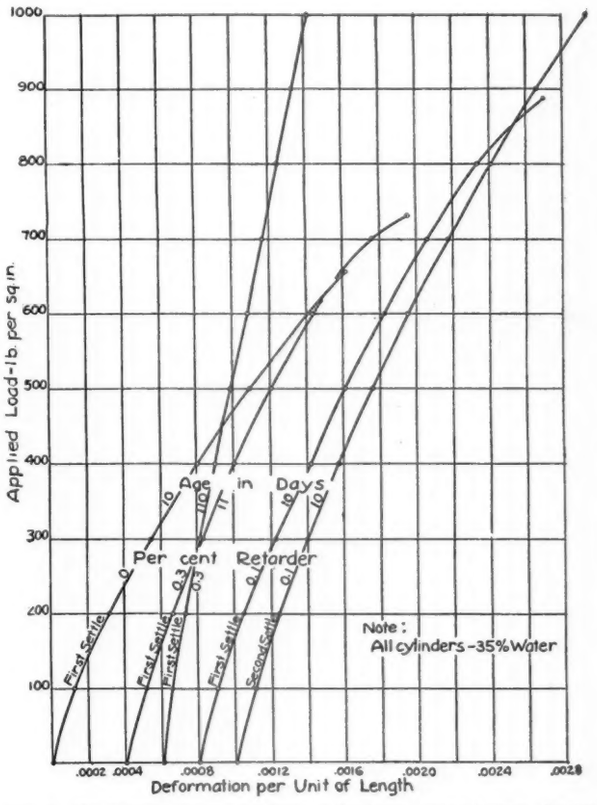


Fig. 4. Stress Strain Curves for Gypsum Specimens under Various Conditions

constant throughout the range of the loading. For the specimens not entirely dry the modulus decreased with the increase of the unit-deformation much as is frequently found with concrete. In the upper portion of this figure the average moduli are plotted as ordinates and the percentage of dryness as abscissas.

"Considerable diversity of values is shown in this diagram, but it seems fair to say that average working values of the modulus of elasticity are 1,000,000 lbs. per sq. in. for dry gypsum, and 750,000 lbs. per sq. in for gypsum not less than 50 per cent dry."

In May, 1925, tests were conducted by Professors A. H. Beyer and W. J. Krefeld at Columbia University to determine the modulus of elasticity of "second settle" gypsum. Six inch by twelve inch cylinders were tested at an age of 28 days. The results obtained are as follows:

Specimen	Modulus of Elasticity in Pounds Per Sq. In.
30288	960,000
30289	942,000
30290	967,000
30291	888,000
30292	880,000
Average	927,400

From these figures it is seen that the tests at Columbia verify the conclusion drawn by Professor Slater that the modulus of elasticity can be assumed as 1,000,000 pounds per square inch. In design, the modulus of elasticity of "second settle" gypsum is assumed at that figure.

In the investigations carried on by Professor

Slater, tests to determine the shearing strength of "second settle" gypsum were conducted on beams in which the reinforcing consisted of straight bars only, in which bars with hooked ends were used, and also on beams in which bent up bars were employed.

Concerning these tests on shear, the following is quoted from the paper by W. A. Slater and G. P. Anthes:

"Under conditions comparable with those which existed in these tests and where stripping and bond failure are eliminated, failure by diagonal tension in beams without web reinforcement does not seem likely to occur when the shearing stress is 80 lbs. per sq. in. or less."

With reference to shearing strength in beams in which bent up bars were used, the following is quoted:

"In beams 15EA1 to 3 employing only through bars, failure was by diagonal tension, with some cracks resembling stripping cracks. The average maximum shearing strength was 90 lbs. per sq. in.

"The average shearing strength for all beams with bars bent up was 213 lbs. per sq in. The highest strength (average for three beams) was found in beams with bars bent up at 20 degrees, the first bend being at a distance d from the load-point and the second bend 2d from the first bend. In these beams the average shearing strength was 228 lbs. per sq. in. or 2.6 times as great as for those with no bars bent up. The lowest average strength for a group with bent-up bars was 2.4 times as great as the average for beams with no bars bent but having anchorage."

The shearing stress which is advocated to be used as a maximum is 30 lbs. per sq. in. With the above test data in mind, it is readily seen that this gives an ample factor of safety especially when it is considered that, in all construction which consists of neat "second settle" gypsum, adequate web reinforcing is provided. Moreover, it should be noted that in the pre-cast roof tile, which is the only type of construction at the present time which consists of neat "second settle" gypsum, the working stress in shear is considerably less than the allowable 30 lbs, per sq. in.

Messrs. Slater and Anthes determined values for the bond resistance of gypsum from tests on beams with and without anchorage of the reinforcing and on pull-out specimens. Beams reinforced with a straight bar without any end anchorage and which were about 25 days old failed in bond at an average computed stress of 129 lbs. per sq. in. In beams having three ¼ inch round straight bars with no end anchorage, an average bond stress of 119 lbs. per sq. in. had been developed when failure occurred due to diagonal tension and stripping. These specimens averaged about 32 days in age. For beams reinforced with straight bars which had hooks at the ends, values in bond up to 158 lbs. per sq. in. were obtained, the average being 117 lbs. per sq. in. The average age of the specimens

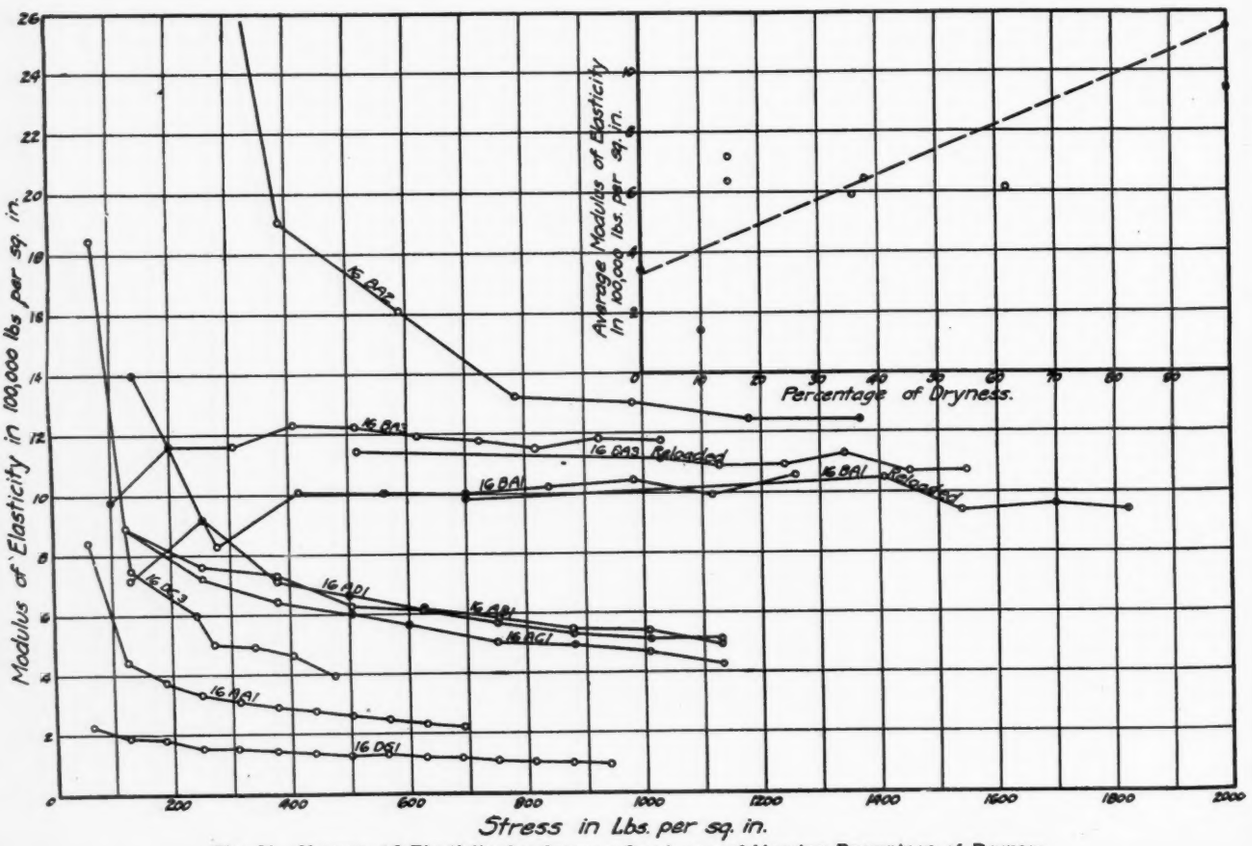


Fig. 34. Modulus of Elasticity for Gypsum Specimens of Varying Percentage of Dryness

was 29 days and the failures were due to diagonal tension and stripping.

The recommended maximum allowable working stress in bond is placed at 40 lbs. per sq. in. The above tests show that this is a safe figure to use especially when it is remembered that in the pre-cast structural units an electrically welded mat is used for reinforcing. The disposition of the steel in the mat and the mechanical bond afforded by it make it very efficient in withstanding the stresses which are due to bond.

Gypsum Concrete

Floor or roof construction in which gypsum concrete is used may be either poured-in-place or pre-cast. In such constructions the gypsum concrete functions structurally and the design is based on the same principles as those of reinforced portland cement concrete. Gypsum concrete may be either gypsum fiber concrete or gypsum coarse aggregate concrete. As described under the suspension system, gypsum fiber concrete consists of a mixture of "first settle" gypsum with not more than 12½ per cent by weight of wood chips, excelsior or fiber. The fiber content is measured in a dry condition as a percentage of the dry mix. Gypsum coarse aggregate concrete consists of a mixture of "second settle" gypsum, sand, and broken stone, gravel, crushed blast furnace air cooled slag or steam boiler cinders. The gypsum, sand and coarse aggregate are mixed in the proportions of 1½ parts of gypsum, 1 part of sand and 3 parts of coarse aggregate by volume.

Gypsum fiber concrete in this type of construction is used in floor and roof constructions consisting of reinforced poured-in-place or pre-cast slabs on steel supports spaced not to exceed 36 inches on centers and reinforced ceiling slabs hung from these supports. The minimum thickness of the floor slab is 2½ inches and that of the ceiling 2 inches. Gypsum fiber concrete in this type of construction is also used in poured-in-place floor and roof installations in which a gypsum board or metal lath is used as a permanent form or centering. In roof construction of this nature, purlin spacings up to 10 or 12 feet can be used, the intermediate supports for the slab being spaced about 32 inches apart. Gypsum coarse aggregate concrete for floor and roof construction is used mainly in connection with steel joist construction.

As is the case in the structural use of neat "second settle" gypsum, which has been discussed previously, working stresses and the values of the constants used in design in which gypsum concrete is used, have been developed as a result of test data.

Gypsum Fiber Concrete

Tests to determine the ultimate compressive strength of gypsum fiber concrete mixes were conducted at the Pittsburgh Testing Laboratory and reported upon in March, 1926. The results of these tests are as follows:

Size of Block	Ultimate Compressive Strength in Pounds per Square Inch						Remarks
	AK1 41.2% Water	AK2 44.4% Water	AK3 45.9% Water	GY1 41.2% Water	GY2 44.4% Water	GY3 45.9% Water	
4″x 4″x4″	592	525	474	502	433	377	No column action. No restraint.
4″x 4″x8″	552	453	422	432	410	382	Column action. No restraint.
4″x12″x4″	650	567	552	593	517	466	No column action. With restraint.
4″x12″x8″	603	489	482	501	443	392	Column action. With restraint.
Average	599	508	482	507	451	404	

Note: Last figure in size of block denotes approximate height of specimen.
AK denotes gypsum from Akron, New York.
GY denotes gypsum from Gypsum, Ohio.

In the above tests the mix consisted of "first settle" gypsum and 12½ per cent by weight of wood shavings. There were four samples of the 4″x12″x4″ specimens tested for each different percentage of water content of both the Akron, New York, and Gypsum, Ohio, materials and six samples of each of the other sizes. In all, there were 132 test specimens. Your attention is called to the different percentages of water in the various specimens. A water content of 41.2% represents normal consistency. The purpose of the tests in which the higher percentages of water were used was to determine the effect of an increase in the water content on the compressive strength. A study of the table shows that the water-gypsum ratio is of importance just as is the water-cement ratio in the case of portland cement concrete.

Additional tests conducted at the Pittsburgh Testing Laboratory during July, 1926, gave the following results:

Block	Mark	Size	Ultimate Compressive Strength in Pounds per square inch Water Content—41.2%
1	GY1A	4″x12″x4″	607
2	GY1A	4″x12″x4″	601
3	AK1A	4″x12″x4″	622
4	AK1A	4″x12″x4″	643
Average			618

In these tests, the 4″x12″x4″ blocks were also composed of 87½ per cent by weight of "first settle" gypsum and 12½ per cent of wood shavings.

Data concerning the compressive strength of gypsum fiber concrete have also been developed as a result of tests conducted at Fort Dodge, Iowa,

on mixes with various percentages of fiber content. The following table gives the average compressive strengths developed for the mix which contained 14 parts of shavings to 100 parts of stucco (12.3%) by weight. The averages given below are each determined from eight test samples.

Parts of Shavings to 100 parts of stucco	4″x8″ Turned Cylinder	4″x4″x4″ Cubes	2″x4″ Turned Cylinder	4″x8″ Control Cylinder
14	620	779	617	797

The average of the above determinations is 703 lbs. per square inch.

Based on the tests described above, the standards of our industry require that gypsum fiber concrete which contains not more than 12½ per cent by weight of wood chips, excelsior or fiber shall develop a minimum ultimate compressive strength of 500 lbs. per sq. inch. The working fiber stress in compression in flexure which is used is 125 lbs. per sq. inch. This gives the usual factor of safety of 4.

In the tests conducted at the Pittsburgh Testing Laboratory in March, 1926, which were referred to previously, determinations were made of the modulus of elasticity of gypsum fiber concrete as well as of ultimate compressive strength. As indicated before, the mix consisted of 87½ per cent "first settle" gypsum and 12½ per cent of wood shavings. The determinations for the value of the modulus of elasticity were made from the same specimens which were tested for ultimate compressive strength. The results obtained are as follows:

Approximate Size of Block	Modulus of Elasticity in Pounds Per Square Inch					
	AK1	AK2	AK3	GY1	GY2	GY3
	41.2% Water	44.4% Water	45.9% Water	41.2% Water	44.4% Water	45.9% Water
4″x 4″x4″	244,000	176,300	132,200	140,200	202,400	196,200
4″x 4″x8″	470,200	384,300	401,500	391,300	386,700	363,100
4″x12″x4″	112,200	119,800	128,000	125,100	124,800	119,400
4″x12″x8″	215,900	138,600	165,000	177,500	175,800	160,200
Average	263,020	204,750	206,670	208,520	222,420	209,720

When gypsum fiber concrete is used in systems in which the gypsum functions structurally, the modulus of elasticity is of course a constant which is involved. It has been necessary, therefore, to develop test data concerning this matter.

Other tests conducted by a gypsum manufacturer at one of his mills show the average value of the modulus of elasticity of gypsum fiber concrete consisting of 12 parts of wood shavings to 100 parts of stucco to be 186,500 lbs. per sq. in. This result is the average of eight tests on 4″x8″ turned cylinders.

By referring to Technical News Bulletin No. 115 (November, 1926) of the United States Bureau of Standards, it will be noted that tests conducted at the Bureau of Standards give values of 199,000 lbs. per sq. in. and 192,000 lbs. per sq. in. as the modulus of elasticity of gypsum fiber concrete containing 12 per cent of wood chips and wood fiber respectively. Three specimens were made of each mix and the samples were dried in the laboratory for fourteen days before testing.

The value of the modulus of elasticity is assumed to be 200,000 lbs. per sq. in. The results of the tests which have been enumerated show that such an assumption is reasonable and justified.

A rather comprehensive investigation is being conducted at the United States Bureau of Standards at the present time to develop further data on the physical properties of gypsum fiber concrete mixes. These tests will form a very valuable contribution to the available data on the subject.

Gypsum Coarse Aggregate Concrete

Tests to determine the ultimate compressive strength of gypsum concrete in which cinders are used as the coarse aggregate were conducted at Washington University during March and April of 1926 and at the Armour Institute of Technology in April of the same year. In each case, the mix was 1½ parts of "second settle" gypsum, 1 part of sand and 3 parts of cinders, and the specimens were 6″x12″ cylinders. In the tests at Washington University, the samples were stored for one week in a cool room and for one week at 85° F., the age of the cylinders when they were tested being fourteen days. In the investigations at the Armour Institute of Technology, the cylinders were tested at the age of 30 days. The results obtained from these tests are given in the following table:

Specimen	Ultimate Compressive Strength in Pounds per square inch Gysum Cinder Concrete
Washington University	
C4	1345
C5	1330
C6	1085
C7	1060
C8	1025
Average	1169
Armour Inst. of Technology	
1	1050
2	1010
3	1070
Average	1043

In the April, 1926, tests at the Armour Institute of Technology the following values on a 1½:1:3

(Continued on page 87)

NEED FOR COST ACCOUNTING SYSTEMS

By J. J. Berliner

A COST system may be defined as a method of allocating to the manufactured product all expenditures for the normal operation of a factory. The object of a cost system, as the name implies, is to determine costs. Its primary purpose is to aid those in charge of the operation of a factory in attaining greater efficiency. Thus, the cost system must serve to determine through experience minimum costs from which standards may be established as goals to be attained in future production; to safeguard the maintenance of those standards, or to establish new, lower standards in subsequent operations; to assist in the assignment of work to employees best fitted for it; to hold to accountability those responsible for the various items of cost; and to determine the unit profit arising from the sales of various articles made in the same factory.

The cost system presents a financial history of the operations of a factory. It is not in itself corrective; it merely points the way to better results. But its aid must be sought. To reap the benefits from it the figures must be constantly analyzed and used as a guide for present and future operations. It will prevent a repetition of the errors of the past.

A cost accounting system gives detailed information as to the cost of each unit of work or product manufactured; the cost of operating each manufacturing department, the sources of profit, and the results of the operation of the entire business. It also permits the analysis and comparison of these facts so that the management may be able to conduct the affairs of the business successfully.

Why Cost Accounting Is Necessary

The expansion of manufacturing industries in recent years has been along certain well defined lines. These are: an increase in the size of manufacturing plants; an increase in the number and quantity of products manufactured; and an increase in complexity of manufacturing processes and method. The modern factory occupies more space and employs many more workers than did the factory of a generation ago, with the result that the management can no longer have personal acquaintance with all the activities within the plant organization. Differences in requirement have led to an increase in the number, kinds, and types of products manufactured, while increased demand has caused production to be conducted on a larger scale than in former years. This has added to the burden of management by increasing the production problems to be solved in handling a variety of products. Inventive ability has made possible numerous methods of accomplishing similar results and has led to refinements and exactitude in manufacturing processes which have greatly increased the amount of detailed information that is necessary for managerial purposes.

Rising costs and more intense competition have also had an effect on manufacturing conditions. The cost of all elements that enter into manufacturing has steadily risen and the increase in cost has prompted greater attention to the avoidance of waste and to more economical methods of manufacturing. It also has necessitated the investment of more capital in order to operate successfully under high cost conditions. Competition has caused the use of more intensive sales methods and has set limits on selling prices that have given additional impetus to the adoption of economies in manufacturing and selling.

These influences have forced upon the attention of the management of manufacturing industries the necessity for more accurate records and accounting methods, and especially for more detailed and exact knowledge of the cost of producing and selling their various products.

Advantages of a Cost System

One of the most important advantages of a good cost system is that it shows accurate unit and total costs. A progressive manufacturer wants to know the costs of his individual units of products. Total costs alone do not satisfy; neither do average costs for the business as a whole. An actual case will illustrate this point. Two manufacturers, A and B, produced several grades of the same product. The former (a) kept only average unit costs for all products. The latter recorded separately the exact unit costs of his different products. At the close of a fiscal period A's profits were disappointing although his gross sales had been large. An analysis of his sales showed that most of the increase was in one line. A calculation of the costs of this line showed that he had been selling it below cost. Since B had realized that he could not meet A's "below cost price," he had been gradually discontinuing the manufacture of this line and buying it from A. Most of A's sales had been made to B, and A's ignorance of his exact costs had forced him to the verge of bankruptcy.

With exact costs, profitable and non-profitable lines are clearly recognized. Thus, sales departments can select the lines on which to allow commissions, can decide on the amount of commissions, and can choose the lines to "push."

The Elimination of Waste

Practical management in the direction of reduc-

ing costs seeks to eliminate all waste in materials and effort, to conserve all materials and brawn by using each in the most productive way and by combining all in such relationships that they render the greatest possible help in bringing the product into existence. If a workman loafs, there is waste, because his wages is a cost for which the business does not get the greatest return. If a process using material has an unnecessarily large percentage of scrap, there is a waste of material which costs money. If scrap is discarded when it could be sold or worked up into a profitable by product, there is waste. If a concern refrains from hiring a department superintendent which would cost them say $5,000 per year and the workmen are less efficient for want of proper supervision, guidance and stimulation to the extent of more than $5,000 per year, there is waste in the management of the business. On the other hand, if a superintendent costs $5,000 and the business could drop him without a $5,000 diminuation of efficiency, he is a wasteful item of cost.

A Basis for Fixing Selling Prices

Unless costs are known, it is impossible to fix intelligently the selling prices of products. It is no longer safe to operate a business by simply adding to manufacturing cost an arbitrary percentage deemed sufficient to cover both factory expense and selling and administrative expenses, and then trust blindly that the selling price will be high enough to cover all costs and to allow the desired margin of profit. The difference between success and failure often depends upon whether costs are figured exactly even to the fraction of a cent or whether they are figured in blind fashion.

Detailed costs depend largely on the time necessary to make the products. Indeed, in the final analysis, what is sold is really: the time of the machinery and equipment, the time of the employees, the time capital is tied up in raw materials and supplies, and the time of the management. Accordingly those products which require the greatest amount of time, should be charged higher; also taking into consideration that work of a complex nature should be charged more than for work which is simple.

Control of Inventory

One of the hardest elements in almost any manufacturing concern is to control the inventory. To ascertain the real value of the materials actually on hand in the store-room has aways been a bugbear of every factory manager. Usually this has been accomplished in the past by taking a physical inventory from time to time, but, as every one who has had experience with this kind of thing knows, the best results are far more satisfactory and the worst are worse than useless. An adequate cost system provides a means for recording the receipt and issue of material so that the value of the balance remaining in the store-room may be found at any time.

It should not be forgotten that if this problem is complex and difficult for purchased material it is doubly so for goods made inside the factory unless there is a good system. The only way to find the cost price of material so made and stored away until it is needed for the final product is by means of the cost records.

The assistance which a good cost system can render a business in connection with its inventories does not stop here, however. It must be remembered that the materials in the store-room awaiting use or in the stockroom awaiting shipment are only a part of the entire inventory. There are, in addition, the goods in process in the factory to be thought of also. To take a physical inventory of all these is even more of a task and less satisfactory than the same kind of an inventory for materials in the store-room. A good cost system provides figures of the value of goods in process at the end of each month, or whenever they are needed, on short notice.

With the inventories before him during the first week or ten days of each month, the executive is in a position to make decisions with definite knowledge in regard to these matters. What is more, he can have a balance sheet ready to present to his bankers and so be in a position to establish the standing of his concern with them in a way which is quite impossible without such aid. It is essential for the factory executive to appreciate the importance of these dollars and cents records of material. Accustomed as he is to thinking primarily in terms of quantities, he sometimes forgets that the quantities represent money which the company must provide in some manner if it wishes to continue in business.

There are in addition certain incidental advantages to be gained from this knowledge of the inventories. Accumulations of obsolete and useless material may be discovered before it is too late to deal properly with them. The detection of losses and thefts of material is also greatly facilitated if adequate cost records are kept. If the material inventories are large, the item of insurance premiums is often a considerable one and the amount of "effective" insurance can be regulated only if inventories are accurately and promptly maintained. Practical experience with particular instances will show other ways in which this inventory information is of value in the business.

Measuring the Value of Equipment

A good cost system provides a means for measuring the worth to the company of its equipment. The question may arise as to whether or not it is desirable to change one machine for another or to modify a process in some way, or to install

additional equipment. It not infrequently happens that the answer to such a question is in the affirmative from the engineering point of view. Production quite possibly may be increased and even improved in quality. If, however, normal production is not sufficient to keep that equipment busy all or most of the time, the burden charge for its use may increase so, that the cost of turning out the product will render it undesirable to make the change.

Expense Control

The problem of expenses is always one which bothers the factory executive unless he has adequate means for recording it. If he has this, he is then in a position to control it. In a continuous process industry turning out a single line of product, to take an extreme instance, the costs of production are not likely often to fluctuate radically. Test runs if properly administered, will frequently give all the needed information in regard to the cost of the product. But even in this case, the manager cannot afford to be without continuous and definite knowledge of what the various departments are costing him to operate—in other words, his expense.

One of the best instruments for the control of an entire business which the executives can have is a budget or schedule of prospective expenses. This enables them to plan for the future in a way which is quite impossible without it. This schedule is only one-half of this means of control, the other half is the record of what the expenses actually are as they take place. With such records in hand, the executive is in a position to measure the efficiency of his various departments, to take steps to check unwarranted increases in expenses and to anticipate difficulties before they come in such a way as either to prevent them or to be ready for them.

Cost System Aids All Departments

Another important advantage of a cost system is that it aids all divisions of an enterprise. Indeed one of the chief functions of a cost system is to point out the future trend of the business. Guided by the historical value of the cost records, the production and selling divisions can use them in estimating future requirements. Instead of looking backwards, they scan the future so as to detect anything which indicates a squall or a storm.

Many progressive financial managers and treasurers estimate immediate and future capital requirements with the aid of cost data. Thus they prevent the tying up of too much capital in inventories, and can arrange with commercial banks for seasonal loans to be used in carrying the "peak" load of the business.

However, it must be said here that in order to accomplish these purposes, cost data should be timely, and available for analysis shortly after the close of each cost period. If the data are too slowly assembled, it is impossible for the production department to ascertain the causes of cost fluctuations in time to apply effective remedies. The sales division wants prompt information also. It should not be forced to plan its campaigns on the basis only of normal or average costs. It needs up-to-date information of current and unusual costs in order to push sales with vigor and intelligence. Much of the value of a cost system is lost by the financial division unless the cost of current units can be studied.

A Basis for Standardizing Costs

The cost used as a basis in fixing selling prices should be the standard costs of normal production rather than abnormally low costs or abnormally high costs. Standard costs occur, according to some authorities, when the plant is running 80 per cent or 90 per cent of its possible capacity. If the plant is running overtime, production is above normal and costs are below normal, provided the concern is operating under the law of decreasing cost or increasing returns which normally it should. Selling prices based on such costs (which are not normal) may be inadequate to cover the costs when production slumps. On the other hand, if selling prices are established when production is below normal and the costs above normal, they may be above the competitive level. As a result, only a small volume of orders may be secured. Thus the importance of standards is seen. Standards are not immutable; they often change overnight while they are fixed and applicable, however, their worth in planning and in enabling comparisons to be made against them is inestimable.

Preparing Statements and Tax Returns

With a cost system, perpetual inventories for raw materials, work in process, part-finished stock, etc., are kept, and it is not necessary to take physical inventories prior to the compilation of financial statements. This enables the preparation of balance sheets which reveal the financial status of the concern and profit and loss statements which show the monthly changes in the financial status of the manufacturing, selling and administrative departments. In addition, statements can be drawn up each month showing such details as the sales of each salesman, or the sales for each geographical unit, etc.

The data in financial statements are also used in preparing the various tax returns. In order to feel sure of filing correct tax returns, costs must be known.

Furthermore the manufacturer must know the sales, costs and profits of customers' accounts before he can judge as to whether it is profitable to carry certain customers. Such data also enable the manufacturer to decide whether he will sell his

goods to his old customers at a lower price than to his new customers, or whether to allow the former some concessions in the way of additional work.

Comparing Periodical Costs and Profits

With accurate profit and loss statements, it is possible to make comparisons for different periods of the costs and profits of the whole business and subdivisions thereof, such as the operating, selling and administrative departments, and for the processes, jobs and lines of product. Furthermore, with detailed cost data a basis is provided for the comparisons of total cost and the various elements of cost with the past costs of similar units, with estimated or predetermined costs of the same unit, and subsequently with the cost of similar units. In order to make cost data valuable for comparisons as between different periods, it is often necessary to keep the details in terms of units of material and labor as well as in monetary terms. By comparing balance sheets as well as profit and loss statements, changes in assets, liabilities and capital can be ascertained.

Carrying Out Policies

With the installation of a cost system, immediate steps to effect savings can be taken. But it is not until the end of the month, or later (depending on when financial statements are completed) when comparisons can be made, between the costs under the old system and the new system that the full effect of economies introduced, can be felt. New policies are then determined, and the rest are measured at the close of the fiscal period.

It is only by the use of cost records, therefore, that the activities of modern business conducted under the factory system can be visualized, and proper policies formulated and carried out.

Summary

The advantages of a cost system, with respect to increasing the efficiency of a plant from an organization viewpoint may be summarized under the following six headings:

1. Perpetual Inventory. The cost records provide for a perpetual inventory which furnishes information for the preparation of monthly statements showing the industrial and financial condition and the operating results of a company. These monthly statements should include:

(a) Balance sheets showing the financial condition of the concern at the end of each month.

(b) Profit and loss statements showing the financial operations of the concern during the month.

(c) Manufacturing statement, or statement of factory expenditures, showing the financial operations of the various departments of the factory during the month.

(d) Statement of salesmen's sales and costs showing the profit or loss of each salesman or territory of the country for the month.

2. Prices and Policy Data. The costs of each product, class of product, or operation being separately shown, the management has the necessary data at hand to guide it in making changes of policy or methods, these including:

(a) Establishing correct selling prices with the true costs as the basis.

(b) Eliminating the manufacture of any product which show losses, and substituting for these more profitable products.

(c) Increasing the efficiency of the salesmen by enabling them to concentrate their efforts on the more profitable articles.

(d) Establishing correct rates of commission for salesmen upon the various classes of products.

3. Comparative Costs. Costs for different periods and under different conditions are obtainable, enabling the following comparisons to be made:

(a) A comparison of each article, job, or operation cost with standard, estimated, predetermined, or previous costs.

(b) A comparison of article, job, or operation cost under various methods of manufacturing, as for instance, daywork with piece-work, piece-work with premium or bonus work, etc.

(c) A comparison of article, job, or operation cost with outside prices under the various market conditions, thus ascertaining when parts or operations may be purchased or manufactured outside at a lower cost than the particular cost shown in the plant.

4. Detection of Inefficiencies. The Records provide for following the material from the raw state until it becomes finished product, and for ascertaining the time, labor, and expense involved in its manufacture. In this way, the following inefficiencies may be detected:

(a) Losses of material.
(b) Wasted time.
(c) Defective work.
(d) Poor supervision.
(e) Various other "leaks."

5. Detailed Inventories. A cost system provides for keeping perpetual inventory records in detail of raw material, work in process, finished parts stock and finished stock.

These records provide a means for discovering or determining:

(a) Losses of material.
(b) Obsolete stock.
(c) Insurance requirements for the merchandise in the various departments of the plant.
(d) Information for the purchasing department as to the quantities of materials on hand and the necessary requirements.
(e) The correct quantities of product which must be manufactured in order to maintain stock requirements.

(f) Information for the sales department as to deliveries on orders.

6. Standardization Data. A cost system supplies the information necessary for standardizing the work of a plant, which might include:

(a) Ascertaining the unit of production upon which the various divisions of the plant may operate efficiently, thereby keeping the various operating departments balanced with each other.

(b) Changing day-work operations to piecework operations, or perhaps to premium or bonus system of paying wages.

(c) Establishing a basis for a planning or routing system of orders in the various departments.

Waterproof Building Material

This is formed by means of bitumen, soap and a hydraulic mortar. An emulsion of bitumen in soap solution is added to a concrete mix. The emulsion is formed by saponifying bitumen mixed with a vegetable oil by means of caustic soda. L. van Westrum (German Patent 454,743).

Mexican National Highway Congress to Be Held at Mexico City

The second Mexican National Highway Congress is to be held at Mexico City from September 19th to 22nd, 1928, under the auspices of the National Highway Commission. The Governments of Cuba and Central American countries have been invited to attend. An exhibition of road-building machinery and materials will be held in connection with the Congress. On September 21st, a demonstration of road-building with modern equipment will be given.

Carefully Installed Equipment In a Crushed Stone Plant

The illustration shows part of one of the screen rooms in a modern stone crushing plant. There are two large revolving screens here, each driven by its own motor and enclosed silent chain drive, shown at the left of the picture. The safety disconnect switch and starting boxes with push button control are shown at the center of the picture. They are mounted on a metal framework and the respective conduits from the panel at the right are seen entering the top of the switch boxes and leaving the bottom of the control boxes, passing under the concrete floor to the motors.

On the floor in the right foreground is a bank of transformers which step the 2200 volt current down to 440 volts for the motors. Lightning arresters are located on the wall near the ceiling on the high tension side of hte transformer bank and disconnect switches have been inserted in the line

Screen Room in a Modern Crushing Plant

on each side of the transformers—namely, between lightning arresters and transformer on the high tension side and between transformer and panel box on the low tension side. The very neat, safe and workmanlike installation of electrical apparatus is obvious from the illustration and a necessary detail of good management.

Artificial Stone

A heat and alkali resisting building material, composed substantially of magnesium ortho silicate, is made by mixing a filler of granular olivine mineral or of magnesium ortho silicate with a binder of materials such as talc and magnesium oxide, which combine when heated to form magnesium ortho silicate. The composition is formed into a paste with water or syrup and is molded and heated to a temperature of 1,300 to 1,500 degrees C., below the fusing point of magnesium ortho silicate. G. Kundsen; Norway. (British Patent 284,576).

CEMENT AND MODERN JURISPRUDENCE

By Justizrat Dr. Fuld of Mainz*

EVEN before the War judicial administration saw itself called upon to deal with the question of definitions of cement on account of unfair competition. It is not surprising, that after the acceptance of the German standard specifications for delivery of uniform character and testing by authorities and consumers, an attempt was made on part of the producers of natural cement to find an outlet for natural cement at the expense of Portland cement. Of late this strife has again taken on a new lease of life. This condition last summer caused the Commission of Standards again to emphasize that the designations "Natural Portland Cement" and "Nature Portland Cement" are misleading. Administrative authorities have taken the stand to define that with Portland cement is to be understood only the product which is up to the requirements of the German Standard Specifications as to uniformity of delivered product and testing as laid down in 1909. The stand taken by judicial administration with regard to the designation of cement is as follows: The Reichsgericht in a decision of January 30, 1912 has taken the position that the designation of a brand of cement as Portland cement which does not inclusively answer the requirements of the stipulated demands is false and improper and has a tendency to make the impression of an especially favorable offering and that it is a matter of indifference with regard to the question of the offering coming under the caption of paragraphs 1 and 3 UWG as to whether the quality of the goods offered comes up to that of which the name has been made use of improperly. Similarly, judicial administration has taken a stand with regard to the question as to whether natural cements or slag cements may be designated directly or indirectly as Portland cements. A decision given by the Landgericht of Brunswick is of especial interest with regard to this as the court in dealing with the evidence laid before it has taken in consideration that the matter primarily does not concern learned persons especially professors in technical high schools or manufacturers, but dealers in building materials and building contractors who cannot be expected to be sufficiently informed with regard to all the details of cement production. The court, accordingly with good reasons has not made any statement with regard to the nature and manner of the declarations but has given its opinion on its own initiative. Furthermore attention is called to the fact that the Reichsgericht in its interpretation of the law dealing with unfair competition has taken the stand that with regard to claims for any goods they must be couched in clear and non-ambiguous terms so as to prevent any interpretation of the same in an incorrect sense even if only by a portion of readers or consumers, this is incumbent on all merchants and producers, other statements are not permissible and give rise to successful actions for omission. The matter does not concern that all readers or consumers may be deceived, it will suffice if this is the case even with a quite small minority. And, again, the Reichsgericht takes the stand that the total effect of the announcement with regard to the average conception of the same is to predominate and that the opinion of the court does not decide, still less that of commerce, wholesale and retail trade, but on contrary, as said, solely that of the immediate consumer. On this account it is quite a matter of indifference whether experienced dealers in building materials, state and municipal building administrations and large contractors may not be deceived, it would be a denial of the results of the finding of the judicial administration of the country were the court to produce evidence with regard to this, such a position would certainly be disapproved of by the Reichsgericht. Inasmuch as the German standards are recognized in most other countries, the position of judicial administration in these is only the same. Designations such as "Nature Portland Cement" and "Natural Portland Cement" are not considered permissible also in Holland, Belgium, etc. In conclusion it may be mentioned that the decisions of the Superior and Supreme Courts with regard to designations of cements offer a guiding line to the actions against misleading statements and reminds us that a uniform regulation of a large portion of industrial competition has been made a field of activity of the Völkerbund. It can be accepted with certainty that the decisions of the German judicial administration, also with regard to designations of cements, will not remain unheeded, a matter of considerable importance for the German Portland cement industry with reference to the foreign competition.

*Reported and translated by Universal Trade Press Syndicate. Paper read at the Regular General Meeting of the Society of German Cement Manufacturers at Berlin, March 13-15, 1928.

Plan Highway Across Mexico

The government of Mexico plans the completion of a highway completely across the country within a period of four years. The road would connect Mexico City with Laredo, Texas, and with the border of Guatemala.

PRACTICAL ECONOMY WELL DEMONSTRATED BY THIS SAND AND GRAVEL PLANT

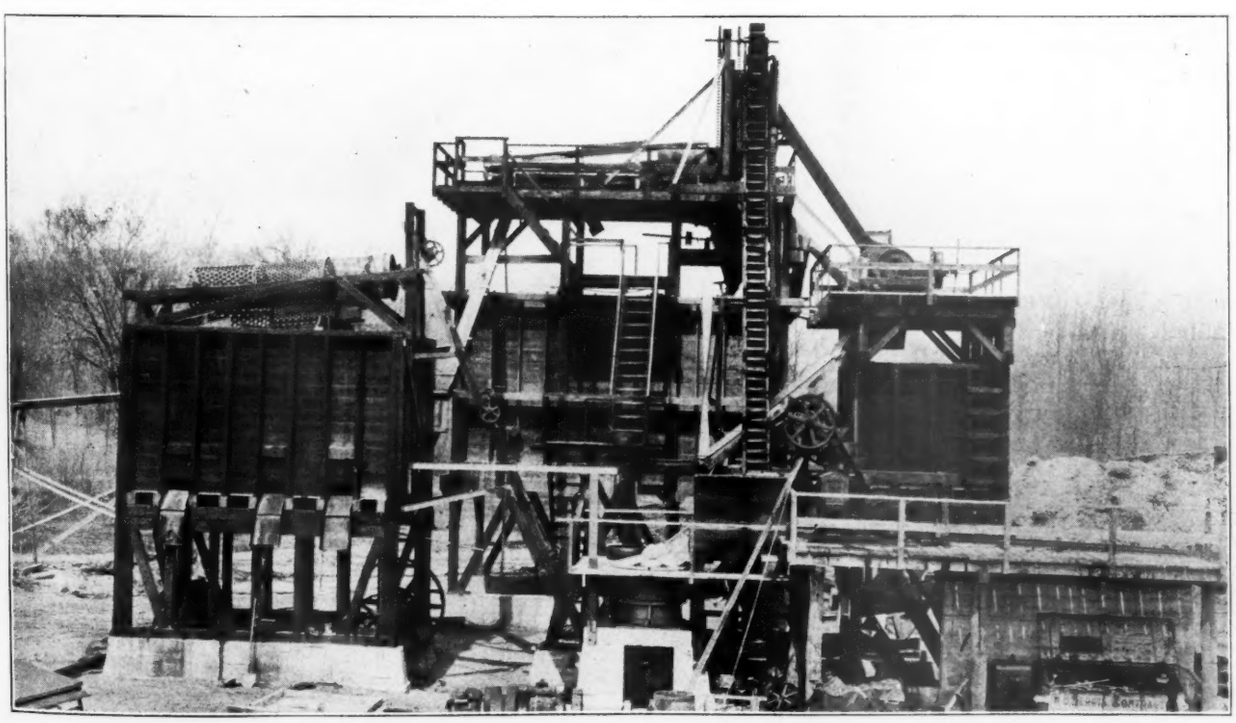
By F. A. Westbrook

ONCE in a while it happens that one runs across a sand and gravel operation which, in spite of comparatively small proportions, is so well laid out and so efficiently managed that it is really almost an inspiration to anyone in that line of business. This may truthfully and emphatically be said of the plant of William B. Ferris at Fairfield, Connecticut, where an average of 300 yards of first class material is produced by Mr. Ferris, his son and one other. These are disposed as follows: one steam shovel operator who excavates the bank and loads the dump car, one hoisting engine operator who hauls up the dump car and discharges it into the grizzly and Mr. Ferris himself who stands most of the time on a sort of ship captain's bridge at a high elevation where he can observe all operations and give his attention wherever needed—which is not often necessary.

Before giving a description of the plant and machinery something must be said of the policy which is followed by Mr. Ferris in order to appreciate the full significance of the various physical and mechanical details. In the first place, Mr. Ferris has made a very characteristic remark which is full of food for thought, namely, that "machinery is cheaper than help and Monday morning you have it." This explains why the mechanical side of the plant has been so highly developed. Furthermore, he believes that the best machinery, even if it costs a little more to begin with is the most economical to run. Probably not many will dispute this statement but by no means all act on it—perhaps because they are not as good business managers. Another policy of equal soundness is that of charging

Belt Loader, Used for Making Stock Piles and Loading Trucks

a good price for a uniformly good product and maintaining that price for all orders, irrespective of size or personality. Eight different materials are produced in order to be in a position to supply a customer with what he asks for. Mr. Ferris also believes in doing his own trucking because he feels that he is entitled to whatever profit there is in this part of the business, and he does not permit building contractors to do their own hauling. That these policies are successful is demonstrated by the



General View of Plant, Crushed Rock Bin at Left, Crusher Above, Washed Sand and Gravel Bin in Center

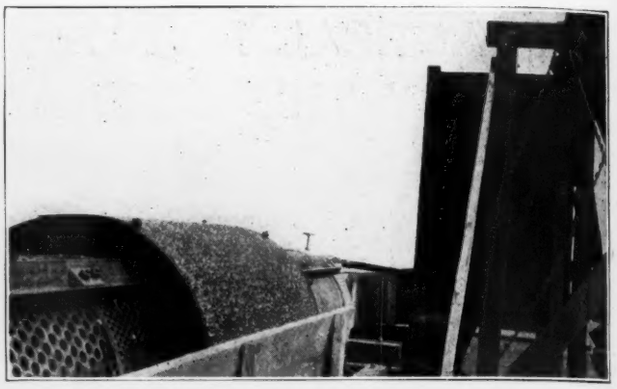
Wm. B. Ferris, Owner and Operator of Plant

fact that as much sand, gravel and crushed stone can be sold as it is possible to produce.

The arrangement of the plant is Mr. Ferris'. Practically all of the machinery was supplied by the Smith Engineering Works of Milwaukee, Wisconsin, which also assisted in certain details of design and installation. The various illustrations give a good idea of its appearance.

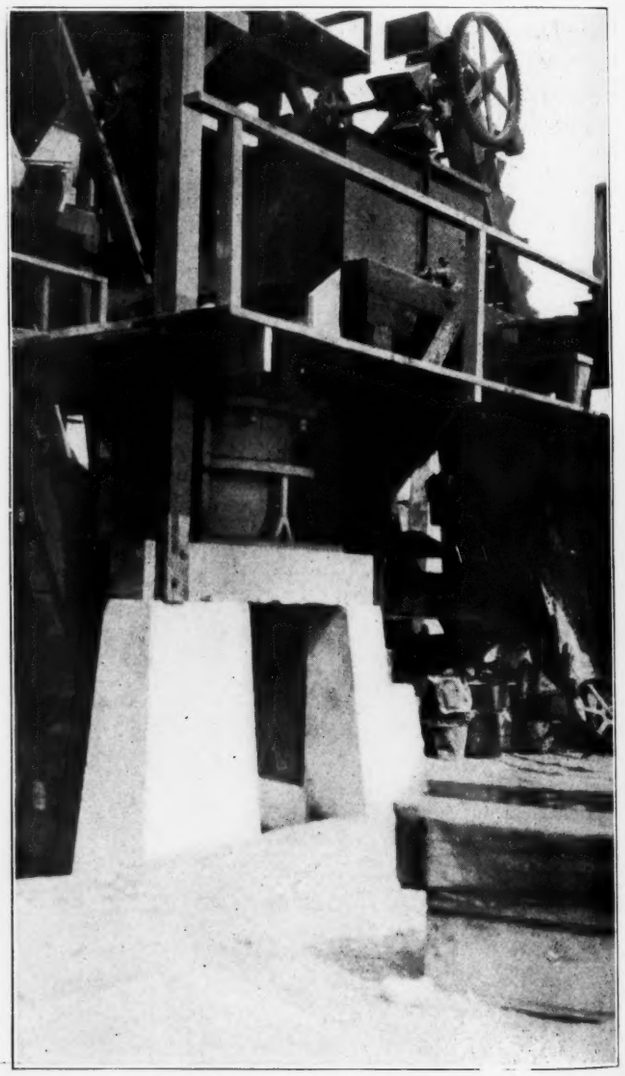
The property consists of about 18 acres with a small river forming part of the boundary and from which an ample supply of water is available for scrubbing at all seasons. Quite naturally the plant has been located within easy reach of this supply.

Screen for Road Gravel Showing Clutch at Left

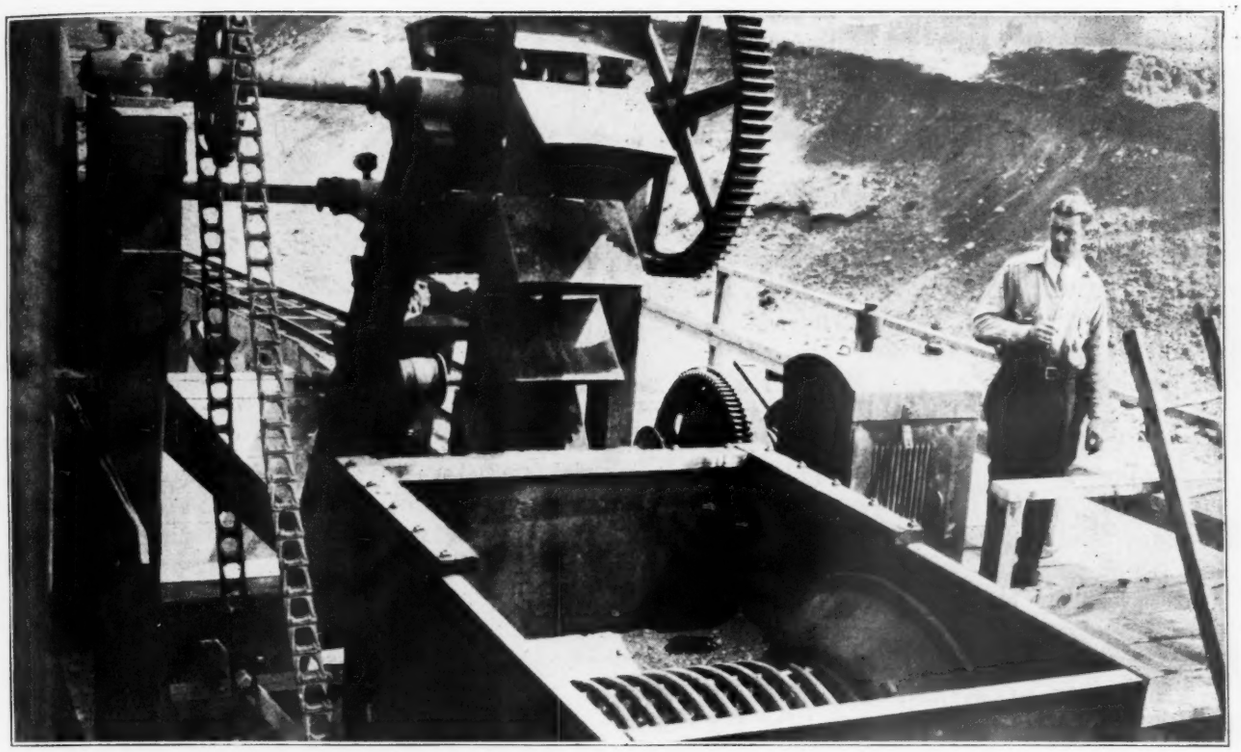


Washing Screen at Left and Tank at Right

Excavation is carried on with an Erie steam shovel which, as already stated, loads the bank material into a Koppel side dump car. This is then hauled up an incline having Sweet Steel Co. tracks by means of a Patten hoisting engine provided with Roebling wire rope and driven by a Le Roi gasoline engine. The man who operates this hoist, usually Mr. Ferris, Jr., also dumps the dump car. From here on, it is to be noted, all operations are entirely mechanical, except for incidental attendance. Con-



New Crusher with Revolving Grizzly Above



Revolving Grizzly with Elevator and Wm. Ferris Jr., Standing at the Hoist.

sequently it will be observed that a direct, and successful, effort has been made to have all mechanical devices necessary to insure smooth and continuous operation all along the line. Thus the hopper into which the pit car is dumped is provided with a Telsmith feeder to regulate the flow into the elevator which carries it to the Telsmith revolving grizzly. This latter machine has been a great success as it has entirely obviated the necessity of an attendant to prevent clogging and secure a very satisfactory separation of sand and gravel from the large stones.

At this revolving grizzly the flow of material separates in two directions. We will first consider that which passes through it. This is picked up by a Reliance elevator brought over from the old Ferris pit, described in a previous issue of Pit and Quarry, and discharged into a tank and mixed with

General View of Pit Showing Inclined Tracks and Shovel in Background.

water at the top of the plant. From this tank the mixture flows into the Telsmith scrubber and thence into the manganese steel revolving screens. A 2 inch perforated steel pipe extends through the screen so that thorough washing is accomplished. The water piping is equipped at various points with Crane valves.

The sand passes into a Telsmith settling tank from which it is discharged into a bin. Grit and one inch gravel drop into their respective bins while the tailings pass through a chute to the crusher.

It sometimes happens that there is a call for road gravel simply to be used for dumping on a road without further treatment, or for fills. This material does not require washing but it is wanted with different sizes of gravel. When this is wanted the mixed sand and gravel brought up by the elevator from the revolving grizzly can be diverted at the top of the plant from the water tank and passed directly to a revolving screen. This is arranged so that sand mixed with one inch and 1¼ inch gravel may be obtained—the two sizes being deposited in separate bins. The tailings from this screen also pass through a chute back to the crusher. This screen is run only when road gravel is to be produced and is then connected with the power shafting by means of an F. & M. Co. clutch.

Returning now to the revolving grizzly, we find that the large sizes of stone which do not pass through are diverted into the crusher. This is a Telsmith Primary Breaker, size 8-A, equipped with automatic lubricating system. It has just been installed and a generous size was selected so that there could be no danger of the crusher being choked at any time, as in the neck of a bottle, and

Crushed Stone Screen

which would render it unable to handle the material sent to it from the grizzly and revolving screens in the form of tailings and thus curtail production; obviously, to keep the plant functioning smoothly in all of its parts, it is essential that all machines must work not only in synchronism but that each must handle all the material fed to it. This is especially important where such a small crew is employed.

From the bottom of the crusher the stone is raised by a Telsmith elevator to a third Telsmith revolving screen of manganese steel and sorted into three sizes—screenings, 1½ inch and 2½ inch.

The whole plant, except the hoist already mentioned, is driven by a 60 h.p. Hercules gas engine through a Twin Disc clutch. All belting is Goodyear "Blue Streak."

Water for scrubbing and washing is supplied by a 5 inch Lawrence centrifugal pump having a capacity of 450 gallons per minute. It is direct-connected to a 15 h.p. Le Roi gasoline engine. Water from the washing operations is returned to a set-

Steam Shovel for Loading Dump Car at Bank

tling pond which is close to the river and overflows into it. Crane steel flanged pipe is used here.

Of course it is as necessary here as elsewhere to have stock piles and in fact this is an essential part of the policy of being in a position to furnish the kind of material asked when desired. The piles have been made by trucking from the bins to the storage space and building up with a Conway belt loader equipped with a Le Roi gas engine. A Link-Belt loader will probably be purchased this season to assist in loading trucks from these stock reserves. Riker and G. M. C. trucks are used. Gulf gasoline and lubricants are used exclusively in all departments.

Clean Aggregate Necessary For Concrete Floors

Charles E. Covell, eastern construction manager of The Austin Company, in a paper presented at the 24th annual convention of the American Concrete Institute at Philadelphia, February 28, 29 and March 1, gave an interesting account of the difficulties encountered by his firm in attempting to make heavy duty concrete floors with the greatest possible resistance to surface wear and dusting. Floors of sufficient strength to resist compression and shear due to static loads of machinery and materials were easily obtained by using a proper slab thickness, adequate reinforcement, and care in producing a uniform concrete of predetermined strength; but to produce a floor that would resist the surface wear and dusting due to impact and the abrasion and crushing of the surface particles caused by steel truck wheels, the shoes of the workmen, and loads dragged over the surface, was found to be a more difficult matter.

In 1923 a bulletin for the use of superintendents was prepared with the cooperation of the Portland Cement Association. Features which received special stress were:

1. That no concrete should be poured using a wet and sloppy mix but that it should have such a consistency that screeding and floating would be required to bring water to the surface.

2. That concrete must be mixed for not less than 1¼ minutes and longer if possible, up to 2 minutes, calling attention to the fact that concrete mixed for 2 minutes was about 35 per cent stronger than when mixed for ½ minute.

3. That properly graded aggregates were very necessary and that aggregates for floor work must be strictly in accordance with specifications.

4. That proportions specified must be followed strictly and that no attempt be made to save cement.

5. That it was very important to test the fine aggregate for organic impurities in accordance with instructions given.

6. That only trained, qualified men were to do the floor finishing and that superintendents were not to use, as had been a common practice in the past, anyone available at the time who was doing nothing else in particular.

7. That floors were to be troweled as little as possible commensurate with a smooth surface.

8. That absolutely no "drier" was to be used in surface finishing.

9. That floors should be properly cured for a period of at least ten days, or longer, if possible. Data of the Portland Cement Association were furnished and attention directed to the fact that proper curing increases the strength and resistance to wear very materially.

After these rules were put into effect a marked improvement was noted in the quality of the work but it still was not up to the standard desired. Tests of different sands were made but none was found with such a small amount of very fine matter that it would not be brought to the top or wearing surface of the slab through the suction created by screeding, floating and troweling. This process of finishing also had the effect of carrying off the cement in the top of th slab. Then when a drier was used to absorb the excess surface water, a very hard surface would be formed by this drier under which would be the fine material brought to the top. These tests proved conclusively that it was impossible to get a hard wearing surface by using this method. This left only two choices, the first being to secure a sand absolutely free of loam organic impurities which could only be accomplished by installing special washing and screening machinery to take out the fine material. This method however was so expensive as to be almost prohibitive. The second method was to use a sand which would meet ordinary specifications and after the floor had hardened remove the surface skin of poor material by grinding. This method was given a trial and proved very satisfactory. The grinding was done by hand-operated electrical grinding machines, using sand as an abrasive material under the cutting heads, and using plenty of water during the operation. The cost of grinding was found to be very small and further saving was made because little preliminary finishing was required before grinding. Some of the important facts learned were:

1. At least ten days must be allowed to water cure the floor before grinding it.

2. Coarse aggregate containing any considerable amount of flat elongated particles or of soft particles will cause pitting of the surface when the floor is ground.

3. The top surface of the concrete floor must be of a richer mix than that obtained by the use of a 1:2:3½ or 1:2:4 concrete.

4. The use of a smaller maximum size of aggregate in the top will give the finished floor a more uniform appearance.

RESISTANCE OF BLAST FURNACE SLAG TO ABRASION AND WEAR*

THREE general opinions exist regarding the value of abrasion tests on mineral aggregates. There are engineers who place little reliance on laboratory determinations; there is a group which is only mildly interested in the question; while the third group is convinced that the abrasion test is of prime importance. Several wear tests have been developed of which some are on the individual material, and others on the concrete in which slag is the aggregate. The tests in this symposium are considered under tests of three classes on blast furnace slag of three classifications, and on blast furnace slag concrete. To make the standard Deval abrasion test, the machine used consists of several cylinders mounted at an angle and rotated at a given speed for 10,000 revolutions, after being charged with approximately 5000 grams in weight which are made up of 50 pieces of slag of similar size and shape. All material passing a $\frac{1}{16}$ inch sieve after the test, when expressed as percentage of the original weight of the sample, is the loss by abrasion.

Data developed with the Deval machine by A. S. Rea on slags show that the average abrasion of 15 heavy slags was 15 per cent; for 10 medium slags, 12 per cent; and for 15 light slags, 27 per cent, or a general average of 15.4 per cent for all 40 samples with a range of from 2.8 to 43.2 per cent. More recent data presented by Fred Hubbard show much lower abrasion losses by the Deval test. The 200 samples were taken at 16 slag plants over a period of one year and tested according to the method designated by the American Society for Testing Materials. They showed a loss ranging from 3.6 to 24.7 per cent with an average of 13.7 per cent. Two samples of blast furnace slag are included in bulletin 370, United States Department of Agriculture with losses of 5.8 and 9.3 per cent, by abrasion and the final report in bulletin 1132 showed a range of from 2.4 to 26 per cent with a general average of 13.5 per cent loss. The National Slag Association has published data on 56 road samples of blast furnace slag used in Pennsylvania and Ohio which had a range of 6.2 per cent to 21.7 per cent with an average abrasion loss of 12 per cent.

For testing blast furnace slags for use in concrete, a modified Deval test developed by A. S. Rea which consists of adding 6 cast iron balls to the charge in the cylinder, has been used. This adds to the severity of the test since the weight of the sample and the number of revolutions remain the same as in the standard Deval test. Recent tests by the Rea method which were conducted by the Standard Slag Company and reported by Fred Hubbard showed that 197 samples taken in Pennsylvania and Ohio averaged 26.6 per cent abrasion loss. Similar tests made by Duff A. Abrams in the laboratory of the Portland Cement Association showed an average abrasion loss of 15 per cent.

Duff A. Abrams has developed a modified Deval test in which the charge of slag is reduced from 5000 to 4000 grams, the charge of balls increased from 6, as in Rea's test, to 10 in number, and the number of revolutions decreased from 10,000 to 2,000. The average of 20 specimens in loss by abrasion was 8.9 per cent.

A German apparatus using a sand blast for the abrasive has been described by H. Burchartz which uses dry steam to propel dry sand against the material to be tested, and the loss per unit of area is computed. The following losses on different aggregates were given in the publication, granite, .09; porphyry, .12; blast furnace slag, .12, and .15; trap rock, .15; concrete plates, .27; sandstone, .77; and limestone, 1.23 per cent.

Tests on Slag Concrete

The Talbot-Jones rattler has been the medium for practically all the laboratory testing of finished concrete under abrasion and wear. In this test, the inner circumference of a steel cylinder is lined with 8 x 8 x 5 inch concrete blocks and an abrasive charge of cast iron balls, weighing 200 pounds, is placed in the cylinder which is revolved 900 times in each direction. The loss in weight, calculated to the average thickness of the concrete removed by the test, is taken as a measure of the wear. Wear blocks were taken from a slag concrete highway in Indiana and tested in the Portland Cement Association laboratory. They were reported, by H. K. Bishop, in the University of Michigan Bulletin, as showing an average of .53 inches of wear for the nine specimens tested. Wear tests, conducted by Prof. Abrams, show slag concrete to be at least equal to other concretes in the Talbot-Jones test. In that series, the slag concrete averaged .48 inches wear, as compared with averages for limestone of .53; for granite .42 and for pebbles .57 inches. Further tests were conducted on 22 samples of slag concrete which averaged .49 inch wear in the Talbot-Jones rattler test. Control tests for the circular track experiment as Arlington, Virginia, included Talbot-Jones wear results. The average for all slag concrete tested showed .23 inches of wear; the average for 10 stones, all from different sources, was .28 inches, and the average for 9 gravels was .30 inches.

(Continued on page 96)

*Abstract of Symposium No. 2, of a collection of data pertaining to the characteristics and uses of blast furnace slag, prepared by the National Slag Association for presentation to its members.

TESTING CONCRETE IN THE FIELD

By C. A. Wiepking*

THE advantages of the transverse test are in the simple apparatus, the low test loads and that the testing may be done on the job, where the results may find immediate application. The men on the job may see the test performed and better appreciate the quality of the concrete. This test has been used quite extensively and several highway organizations have employed it for determining the quality of concrete or the date for opening the pavements to traffic. Several papers have been published, giving the results of field experiences. The cantilever beam was proposed to replace the standard 6 by 12 inch concrete cylinder in the reports of Clemmer and Burggraf, published in 1926.

To conduct the tests a series of mixes was planned to give a large number of batches of average richness of workable concrete so that the uniformity of tranverse test results on the 6 by 8 by 30 inch and the 4 by 6 by 24 inch beams could be compared, the program called for compression tests on 6 by 12 inch cylinders. The ratio of modulus of rupture to compressive strength was to be found for each beam. Batches with different sizes of coarse aggregate, gravel and crushed stone, were planned. Madison sand and limestone screenings were designated for certain batches, because of their individual characteristics.

Part of the program was duplicated with 3 minute mixing instead of 1½ minutes which did not lead to much difference in results, but it did add to the number of values used as a basis for comparison. Specimens were cured under ordinary weather conditions and sufficient were made for 7 and 28 day and one year tests and additional specimens were made for 7 and 28 day damp sand curing. Three specimens were made of each kind for each variable and marked according to a numbering scheme that spread the pieces from each batch among the several test ages.

Apparatus for testing similar to that described by Clemmer and Burggraf in the paper presented at the 1926 convention of the American Concrete Institute was designed. The rigid base, on which to clamp specimens, was made by pouring a rich mix of concrete into a rectangular form about 4 feet long, 14 inches wide and 4 feet high, built against a gravel bin, which made a bench of suitable height and heavy enough to resist overturning. Bolts for clamping the specimens were anchored in the bench by steel plates bedded 10 inches deep. A steel angle was bedded flush at the front of the bench to protect it from wear and act as a bearing edge over which the concrete would break. The first testing lever was 6 feet long and a 12 foot lever was built for use on the strong specimens. The longer leverage reduced the load to break the specimen but required more care in attaching to the test beams.

Some difficulties of the cantilever test are readily apparent, for if a 6 by 8 inch concrete beam is to be broken at 28 days by means of a cantilever the test load will be large. If the concrete is to have a compressive strength of 2,500 pounds per square inch, then the modulus of rupture or beam strength is approximately 500 pounds per square inch. A 6 by 8 inch beam laid flatwise has a section factor of 48 inches^3 and the moment required to break the concrete is 24,000 inch pounds which requires a load of 333 1/3 pounds at the end of a 6 foot cantilever or 166 2/3 pounds at the end of a 12 foot cantilever.

Each beam was bolted to the fixed support and width and depth were measured at the portion of the beam next to the bearing edge. The wooden testing lever was then fixed on to the specimen and a metal bucket attached to the other end of the lever was allowed to fill with sand by gravity from a wood container hopper and consequently the load of sand increased until the specimen broke, when the flow of sand was stopped and the load weighed on the platform scales from which weight the strength of the concrete was calculated. After each break, the broken concrete was examined to determine what proportion of the aggregate had been fractured in the tensile and compression part of the beam, giving an aggregate comparison. One short end piece of each beam was saved for a compression test.

Janesville sand, fineness modulus, 2.6; Madison sand, fineness modulus 1.6; and limestone screenings, fineness modulus 3.1 were the fine aggregates used in different proportions in the different mixes. Janesville gravel, fineness modulus 7.26 to 8; red granite, fineness modulus 7.33; trap rock, fineness modulus 7.50; and limestone, fineness modulus 8, were used in the different mixes. The aggregates were spread on the laboratory floor and occasionally raked until all the excess moisture had dried out and weight per cubic foot tests were made on the dry materials for use in computing batch quantities, and samples taken for the sieve analysis.

The weights per cubic foot of the dry materials were known and the mixes were generally proportioned 1:2:4 by dry volume and the water was weighed out in a bucket on the platform scales. The concrete was mixed in a number 0 Smith mixer at a speed of 28 to 30 r.p.m. The inside of the mixer was wetted and allowed to drain for a minute before the first batch each day so that the

*Abstract of paper presented at the 24th Annual Convention of the American Concrete Institute.

interior of the mixer would not be wetted by part of the mixing water from the batch and the mixer was flushed and drained between batches.

Specimens were removed from the molds on the day after pouring and marked with the mix number and an individual number. The numbers were so arranged that the three specimens of a kind from any batch were designated for testing at different ages. Some were packed in damp sand and kept until the 7 or 28 day test age. Those for dry curing were set in rows on strips of wood and were not protected in any way as the wood strips held them about 2 inches above the ground which permitted the circulation of air under them and prevented absorption of moisture from the earth.

The modulus of rupture from each beam test and the maximum of breaking load was multiplied by the lever arm which was the distance from the loading bucket hook to the steel edge of the testing bench. To the resulting moment was added the correction factor for dead weight of the testing lever which is weight of lever times distance of its center of gravity from the edge of the bench.

The modulus of rupture for a 4 by 6 inch concrete beam is about 17 per cent of the compressive strength of the concrete. The indications are that the transverse strength of gravel concrete does not increase in direct ratio to the compressive strength.

According to the strength ratios, crushed stone concrete may be expected to devedop a higher transverse strength than gravel concrete of equal compressive strength. Evidently the bond of mortar on the rough fractured face of the crushed stone aggregate results in greater tensile strength is reflected in higher moduli of rupture than is obtained with gravel as a coarse aggregate. The crushed stone generally showed tensile failure in a higher percentage than gravel concrete specimens of the same richness and age. In the gravel concretes, some of the pebbles would pull away without fracture, leaving smooth pockets, indicating a lack of bond. Both the 4 by 6 by 24 inch and 6 by 8 by 30 inch beams indicated that the ratio of modulus of rupture to compressive strength is about .23 for crushed stone and about .17 for gravel concrete. For aggregates with different surface characteristics, no doubt other ratios would be obtained.

The practical value of field testing depends largely upon the promptness with which the tests are made available. Any improvement in practice due to more convenient and more simple equipment and due to standardized procedure will lead to corresponding benefits to the manufacture of concrete and to the ultimate owner of the construction. Concrete in the structure generally has a better chance to develop strength than the specimens and any errors due to test conditions will be on the safe side.

The tests were made in the laboratory for testing materials at the University of Wisconsin as a part of the research work of the mechanical department. The illustration of the testing apparatus and graphs of the results contained in the paper are necessary to follow out the described method for testing concrete in the field.

Colored Aggregate Used in Concrete Bridge

S. C. Hollister, consulting engineer, of Philadelphia, presented a paper on "Skew Arch Design and Construction" at the 24th annual convention of the American Concrete Institute, held in Philadelphia, February 28, 29 and March 1. In this paper Mr. Hollister told in detail the methods used in designing and building a 160 foot, single span, skew arch road bridge across the Chester River at Chester, Pennsylvania. It was desired to obtain an exterior finish in which the aggregate would be revealed, so great care was exercised in the selection from supplies submitted by the contractor. A river gravel locally obtained was finally selected, which in appearance was predominantly buff, interspersed with shades of colors ranging from deep purple to dark red, brown and black. The color mixture was quite uniform and did not add any extra cost to the structure. Because of the finish desired the concrete when poured was thoroughly mixed and great care was exercised in maintaining as nearly as possible a uniform consistency. On the following day the exterior forms were removed and the green concrete scrubbed with steel bristle brushes until the aggregate was exposed. This treatment of the surface added materially to the beauty of the bridge when completed.

The bridge is the property of Delaware County, Pennsylvania and was built by the Mundy Paving and Construction Company. Mr. Hollister was the engineer in chief, G. D. Houtman, resident engineer, and S. Borge-Paulsen, assistant engineer.

Concrete and Sea Water

In the decomposition of concrete by sea water, the formation of calcium aluminium sulphate ($3CaO \cdot Al_2O_3 \cdot CaSO_4 \cdot 30\ H_2O$) and gypsum ($CaSO_4 \cdot 2\ H_2O$) play an important role. The former results from the alumina and lime of the cement and the sulphate of the salt water. To inhibit the formation of a calcium aluminum sulphate, three methods are possible: 1. Substitution of an iron oxide for the alumina in the cement, the so-called slag cement. 2. Reduction of the lime content of the cement, as in aluminous cement, and 3. The retardation of free lime formation in concrete by addition of puzzolana, or by the proper change in the modulus of the Portland cement.

VARIATION IN ASPHALTIC FILM THICKNESS ON MINERAL AGGREGATES

ITS RELATION TO DESIGN AND CONTROL OF PAVING MIXTURES

By A. R. Ebberts,
Engineer of Tests, Dept. of Public Works of Allegheny County, Pa.

EARLY in 1925 it was found in the Allegheny County Asphaltic Laboratory, that the figures for bitumen content of our finished mixtures as determined by the N. Y. T. L. type extractor were somewhat too erratic to serve our purposes. Examination showed the errors to be due to poor sampling. The aggregate varied from passing 200 mesh dust to a maximum size of 1¼ inch stone. The most expert samplers available could not obtain within the scope of the capacity of the extractors a sample truly representative of the aggregate involved. For a while, we extracted several samples from each day's run at each plant and averaged the results. Since we run from five to eight plants constantly and turn out an average of 1,200 tons of hot mix daily, this proved too onerous. It was decided that some method of correcting for variation in the extracted sample from the average grading was needed, because it is obvious that the finer particles of any mixture carry more asphalt per unit weight than do the coarser particles. Assuming that this is due to the tremendous difference in superficial area involved, we set out to evolve a method of basing our asphalt requirements on the superficial areas of the different sized particles. Capt. L. N. Edwards has reported in Proc. A. S. T. M., Vol. XVIII, Part II, 1918, what seemed to us to be a satisfactory method for arriving at the superficial area of the average sized particle found between any two screens of any testing series. Adopting his methods, we worked out the weight-area curves and have been using them daily since. His methods were painstaking in the extreme and it is recommended that the reader go to the original source for his information concerning them.

Next in order was the erection of a standard for film thickness in the mixture we were making. This was obtained by taking from the curves the superficial area of the average specified amount of each size of aggregate, adding to obtain the total superficial area of the ideal specified mixture and dividing into the average bitumen content specified. Thus we arrived at a standard film thickness expressed in grams of bitumen per square centimeter area. This figure was dubbed the "BITUMEN INDEX" of the mixture. At this time, we could obtain a reliable bitumen index only from a proven specification.

This gave a method for obtaining some definite information from the extraction and grading of a sample that had always been lacking before. Taking the areas from the weight-area curves, adding and multiplying the total by the bitumen index now gave the amount of bitumen that particular sample ought to carry. This figure could be compared directly with the amount of bitumen actually found by extraction. It could be said with entire assurance that the sample was lean, rich or satisfactory. But we could say more than this. In those cases where it was possible to eliminate cheating on the amount of asphalt being weighed into the mixer, a lean sample always meant that the aggregate was somehow finer than it was intended to be. Conversely a rich sample always meant that the aggregate was coarser than had been intended.

A sample dated 7/19/26 shows an extraction figure of 6.60 and, from casual inspection seems to be satisfactory. However, its total superficial area per hundred grams is only 4,090 square centimeters and it is entitled to 4.91 per cent of asphalt. This sample is therefore 1.69 per cent rich. Since the asphalt was weighed into the mixer by our own men, it was at once assumed that the aggregate was too coarse and the answer found in the lack of sufficient 80-200 mesh material in the sand. Since this size is important to stability the warning was timely and steps taken to correct the error. The sample dated 8/3/26 shows an extraction figure of only 5.27 per cent and appears lean. However, its total area of 4.390 square centimeters demands a bitumen content of exactly 5.27 per cent, so this sample is in perfect accord with the specification. The last sample appears rich, but proved to be a little lean instead. Here again the trouble could not have been in the quality of asphalt used, so we assumed that the aggregate was too fine. Investigation proved that some of the sand was getting into the hot stone bin, due to a clogged screen.

It is desired to emphasize the fact that an extraction and grading report on a sample of coarse asphaltic mixture as usually made by the laboratories is not worth the paper it is written on. It cannot be interpreted, except in the light of the entire specification. The specified grading must be gone over and its total superficial area determined to fix the bitumen index. Then this index must be used in conjunction with the grading of the sample analyzed before the engineer knows whether or not his specifications are being followed. Bitumen content, as determined by the extraction of a sheet mixture, is fairly reliable, because errors in sam-

pling are easier avoided. But, if you send a sample of semi-sheet or coarser mix to a laboratory not equipped to interpret its own results, you are throwing money away, unless you can interpret these results yourself. Every stone in excess of the average in the sample carries only about one-fortieth the amount of bitumen the same volume of mortar would have carried. Every stone below the normal number is represented by mortar carrying forty times as much bitumen as the stone would have carried. Therefore, an uncorrected extraction figure is often amusing, generally exasperating, and always irrelevant.

All of this material, up to this point, may be found in my article entitled "Bitumen Determinations in Coarse Asphaltic Concretes," Eng. News-Record, Sept. 23, 1926. Prior to publication, it was sent to Mr. W. J. Emmons for criticism. He told us at once that the bitumen index would vary with the ultimate fineness of the mixture and that an index suitable for an asphaltic concrete would not do for a sheet asphalt and vice versa. It had already been found that the same bitumen index would not serve for asphaltic concrete carrying widely different percentages of stone. Finally, it dawned on us that if we filled a packing case with footballs and another the same size and shape with dried peas, that there would be more points of contact between the peas than between the footballs. Since any plastic coating would tend to be squeezed out at the points of contact, this looked like a good bet, but it required more courage than we had to attempt to figure points of contact. There would be no other way out, if a mixture might be made from any different sizes of aggregates in any proportion that might happen to suit the fancy of the designer and still be practical. Fortunately, this is not the case.

S. W. Skidmore, in his article, "Design of Bituminous Pavements" (Roads and Streets, Dec. 1925) mentions a mixture that is "of value from the scientific standpoint only." There are many such. Many combinations of aggregates that produce mixes of low voids and high density are yet unfit for use, because they cannot be readily handled under existing conditions. Prevost Hubbard, in his paper "Research Work to Improve Asphalt Paving Mixtures," (Municipal and County Engineering, Dec. 1924), notes that from consideration of his triaxial diagrams for representing sand gradings, that our present specifications seem to be unnecessarily restrictive. Nevertheless it is imperative to proceed with caution in their modifications, if we are to avoid sponsoring mixtures whose practical limitations overshadow their theoretical excellence. A sand, to be of practical value must not only be productive of low voids and high density, but must be well-graded in the sense that the asphalt man has always understood this term. A reliable criterion for good grading is Fuller's curve for maximum density. (Concrete Plain and Reinforced, Taylor and Thompson, Wiley, 1912.)

Fuller's curve as drawn on ordinary rectangular co-ordinating paper consists of an ellipse and a straight line tangent thereto. Fuller places one axis horizontally at a point seven per cent above the X-axis of the diagram and the other vertically at a point designating ten per cent of the diameter of the maximum particle. Fuller was designing Portland Cement Concrete in which the small particles are furnished by the Cement, which is not considered as part of the aggregate. In designing asphaltic concretes, the horizontal axis of the ellipse can be taken coincidental with the X-axis, providing a convenient simplification. In the example shown, the maximum particle is to be one inch and the concrete is to contain 48 per cent stone, all to be retained on a 4-mesh screen. Such a mixture will require about seven per cent bitumen so the total aggregate will be 93 per cent. Therefore, about 45 per cent of the total aggregate will be retained on a 4-mesh screen. The straight line portion of the curve is drawn through the point one inch 100 per cent and .203 inch—48 per cent. Where this line crosses the line X equals .1 inch, gives approximately the length of the semi-major axis of the ellipse, the length of the semi-minor axis being, of course, .1 inch. The elliptical portion of the curve is best constructed with the aid of a slip of paper with these two lengths marked on it after the method given by Fuller. The whole curve can be expressed mathematically, if one prefers, but plotting it is simpler.

If the horizontal indices are changed to conform to sheet asphalt size, this curve represents a mix much like the one from Platte River Sand referred to by Skidmore in the quotation above.

The whole curve approximates a parabola and this can easily be reduced to a straight line on logarithmic co-ordinate paper. Fuller at first used a parabola, but found the combination of ellipse and straight line better served his purpose. Asphaltic concretes can be regarded as mixes where the stone serves as aggregate and the mortar (composed of sand, filler and asphalt) serves as cementing medium in much the same manner as the asphalt alone serves in a sheet mixture. The amount of mortar required depends therefore on the voidage of the stone. If less than enough mortar required to fill the voids were used, it is obvious that an open mix would result. On the other hand, if too much mortar is used, it prevents the pieces of stone from being brought close to each other under compression and the stability of the finished pavement is limited by the stability of the mortar. Thus we lose the advantage of the inherent stability of the coarse stone, which otherwise permits us to sacrifice to some extent the stability of the mortar. increase the voids therein and so make room for the exceptional asphalt which means added water re-

sistance and longer life. It is not claimed that Fuller's curve must be slavishly followed. The claim we wish to make is any mixture of aggregates that does not depart too radically from this curve will result in a dense, stable mixture that can be handled with comparative ease on the job.

Having determined the grading of the aggregate to be used, the next thing necessary is a bitumen index. Two points will suffice to determine the bitumen index, provided a triaxial diagram is at hand. In this instance, the 200 mesh point and the 4-mesh point were used. The data for the construction of this chart was a combination of personal experience and the proven specifications of several technologists as found published in various places. The indices will vary with the type of coarse aggregate used, the printed figure being adopted to crushed limestone. It is not applicable to the mixes. The line designating the percentage of stone on the 4-mesh screen is followed upward to the left until it crosses the line indicating the amount of 200-mesh dust. From this juncture a lime upward to the right leads to the proper bitumen index. All that remains to be done is to determine the total superficial area from the curves, multiply by the bitumen index and reduce the figures to a hundred per cent basis. We have repeatedly designed mixes by this method, using aggregates entirely strange to us, and telephoned the results to the mixing plants. We have never found it necessary to make a change greater than three pounds in a thousand pound batch, after laboratory results were at hand to serve as a guide.

We have also developed a curve for open mixes where the bitumen index depends entirely on the percentage of coarse aggregate employed. In like manner the bitumen index for sheet mixes may be based entirely on the percentage of 200-mesh material used provided the sand is not of a freak grading.

There is a very definite minimum film thickness below which one cannot go without destroying the water-resistant qualities of the pavement. We have carried out no research aimed specifically at the determination of this minimum safe film thickness for the simple reason that we are concerned mainly with asphaltic concretes and, as noted elsewhere in this paper, consider ourselves justified in providing voidage in excess of the absolute obtainable minimum in order to provide room for the excess asphalt that means longer life. However, it is probable that the minimum safe film thickness is represented by a bitumen index somewhere between .0005 and .0007.

Asphalt is a mixture of bitumens mutually dissolved. These bitumens are in the fluid state at ordinary temperatures and are almost totally immiscible with water. Upon this, the water repellent properties of asphalt depend. Glass is another mutual solution, in this case of various silicates, but in glass the solution is super-cooled. By this is meant that the silicates composing glass are crystalloids that are not in the crystalline state, due to the fact that the solution is made while they are in the molten state and cooling is permitted to take place so rapidly that crystallization does not occur. However, the tendency to crystallization is not lost and the various silicates do crystallize very slowly and thus the continuity of the material is lost. This readily is seen in very old glass, such as that made by the Venetians during the Middle Ages. It is doubtful if the bitumens composing paving asphalts have much tendency to crystallize while in the state in which we found them. The solutions are not super-cooled, except, perhaps, in those solid asphalts such as Gilsonite, and we do not use these for paving. However, there are many chemical factors always at work to alter the nature of the bitumens and the potency of these factors increases very rapidly as the thickness of the asphalt film decreases. The law of Mass Action is much more universally obeyed than the Volstead Act. The products of these various chemical actions are much more apt to crystallize than the original bitumens. They are also apt to be water-soluble to a greater extent. Both these tendencies are favorable to rapid weathering.

Some asphalts are much more susceptible to chemical action than others. We say that they age more rapidly. We had on our shelves a year or two ago, a sample of sixty penetration asphalt cement that lost forty-nine points of penetration in a year of standing and the ductility disappeared in like ratio. In an attempt to explain this, iodine numbers were run on this material and several other normal asphalts by the Hanus method, modified slightly to suit the eccentricities of asphalt. The normal sixty penetration asphalts had iodine numbers of from 57 to 60, while the quick-aging sample ran 78. Since the iodine numbers are a measure of chemical unsaturation, we should expect asphalt therefore to be subject to change by chemical addition. Hydration and oxidation probably occur more or less readily and nitrogenation not so readily. All of these actions tend to destroy the valuable properties of the material. It is possible that with the acid of catalysts such as finally divided nickel we might be able to hydrogenate the bitumens composing asphalt and thus increase its degree of chemical saturation. This ought to improve the material.

There is another factor which probably has a good deal to do with the aging of asphalt and that is polymerization. By this is meant the combination or fraternization of two or more molecules of a substance, resulting in a change of properties, which is usually quite marked. An attempt was made to accelerate the aging of a sample of asphalt and to trace any polymerization by the cryoscopic method, using benzol as solvent. The attempt was

unsuccessful, due to some type of combination of the benzol with the asphalt. More work on accelerated aging is planned for the near future.

Any bitumen adsorbed on the surface of the aggregate particles has lost fluidity and gained in concentration by the force of adsorptive attraction. Since the concentrtion of the chemicals reacting upon it, such as water and oxygen, is always relatively great, we can say that it is constant. Since the velocity of any reaction varies with the product of the concentrations of the reagents involved the adsorbed material is much more susceptible to chemical attack than it otherwise would be. Moreover, these reactions are of the first order (unimolecular) and the time required for them to go to completion is always ten times the time required for them to reach the half-way point. Therefore, decreasing film thickness both speeds up the chemical attack and decreases the reserve material for its resistance. This is the mechanism of contact catalysis. In view of these facts, it would seem idiotic not to assure ourselves that our film thickness at least exceeds that of the adsorbed film. At any rate, the adsorbed portion of the asphalt cannot fulfill any void-filling function. We have no information as to the extent of adsorption in paving mixtures. It will be necessary to compensate for adsorption with asphalt before starting to fill the voids, if we desire a reasonably weather resistant pavement. Adsorption is, of course, a direct function of the superficial areas involved. It is not important in open mixes, because the superficial areas are small and the voids large, so we can always use enough asphalt to be safely on the rich side. However, we cannot completely fill the voids of an open mix with asphalt and still handle it on the job. In very fine mixes, we have an extremely narrow range of practical bitumen content. We are limited by small voids on the one hand and the necessity for adequate weatherproofing on the other. Asphalt is a lubricant and that property determines the maximum practical film thickness. Otherwise we sacrifice stability. Thus we must take into account both voids and areas in any system of design we adopt. Design based on areas must care for the voids by varying the bitumen index. Design based primarily on voidage may take care of areas by determining voids in a fluid medium that is adsorbed in perhaps the same ratio as is asphalt. The bulking of moist sand is a well known phenomenon which is probably due to adsorption.

By way of recapitulation, it may be said that superficial areas provide a system for the adequate explanation of discrepancies found in ordinary extraction results. They also provide a basis for design that is accurate enough for all practical purposes. The film thickness obtained with any bitumen content depends entirely on the area that bitumen has to cover, and the film thickness determines the weather-resistant qualities of the pavement.

Uniform Mechanics' Lien Act Revised

A tentative revision of sections 5 and 6 of the second draft of a Uniform Merchants' Lien Act, has been adopted by the Standard State Mechanics' Lien Act Committee, the Department of Commerce announced today.

The amendment of section 5 provides that an owner of property who has contracted for its improvement shall retain from the contractor ten per cent of all money as it becomes due instead of requiring the contractor to give the owner at the time of each progress payment a sworn statement showing his outstanding obligations as was contemplated in previous drafts of the section. The contractor would still be required, however, to submit such a sworn statement before receiving the final payment and the amounts retained by the owner.

Minor amendments have been made in section 6 to conform with those in section 5.

Under mechanics' lien acts which are in force in all states the claims of laborers, materialmen, subcontractors, contractors and others who contribute to the improvement of property are secured by the property improved which, under stated circumstances, may be sold to satisfy these claims when payment is not made by the person from whom it is due. Because of complaints that some existing laws are not equitable and that the differences in present laws cause expense and inconvenience to persons doing business in more than one state and to laborers moving from one state to another, this committee was appointed some time ago by Secretary Hoover at the request of interested groups.

The members of the committee are representatives of the principal groups engaged in the construction industries including the American Federation of Labor. The National Conference of Commissioners on Uniform State Laws, which is a body composed of official delegates from each state and which is interested in all uniform state legislation is cooperating in this work through a committee appointed for the purpose. The recent meeting at which the tentative revision of sections 5 and 6 was made was a joint meeting of the two committees.

The first tentative draft of the Uniform Mechanics' Lien Act was published in the fall of 1926 and the second draft was printed in March of this year. Both were circulated among individuals and organizations known to be interested in the subject in order that the committee might have, through their suggestions, the benefit of a wide experience in the operation of such acts.

SAND AND GRAVEL RESEARCH LABORATORY STARTED BY NATIONAL ASSOCIATION*

"THE country which has no history may be blessed, but certainly the industry which has no scientific problems is headed for perdition." Borrowed words, but they represent the convictions of the Board of Directors of the National Sand and Gravel Association. Those convictions have found tangible expression in the creation of a research laboratory, as a new department of the Association, which will be devoted entirely to the problems of the sand and gravel industry.

It is well to emphasize that a proper research philosophy, which alone can guarantee permanent success and appropriate recognition, involves in no way an undertaking to prove something which can be turned immediately to partisan benefit. A research laboratory should be organized in an endeavor to learn something about the particular materials which form the basis of the investigation. No other industry in the United States approaches the sand and gravel industry from the standpoint of the wide use of its products. No construction project, if it be structure or highway, is completed without the use of sand or gravel in some measure. We, then, are the manufacturers of the elemental building material, and the duty rests upon us to know more about the material than anybody else in the country.

With these introductory remarks, we proceed to the purpose for which the article is written; namely, that the research laboratory of the sand and gravel industry will be an accomplished fact on May 1. It will operate under the direction of Stanton Walker, Director of the Engineering and Research Division of the Association, and C. E. Proudley, Assistant Director. Both of these men are particularly well qualified for the task which lies before them. Mr. Walker, for many years, as the readers of *The Bulletin* already know, was assistant to Professor Abrams in the Structural Materials Research Laboratory of the Portland Cement Association; Mr. Proudley, before joining the staff of the Association was in charge of the Concrete Research Laboratory of the U. S. Bureau of Public Roads.

The laboratory is located in the basement of the Munsey Building in Washington, where the headquarters of the Association are also maintained. This is a fortunate circumstance, for it enables those in charge of the laboratory to keep in constant touch with its active operation, with the fullest conservation of time. A laboratory assistant has been engaged by the Association whose duty it will be to carry out the physical part of the laboratory's activities, and he will have laborers to assist him in his work. The overall dimensions of the laboratory total 22 by 42 feet, and it has been designed in such a way as to promote a high efficiency of operation. A plan of the laboratory, showing the tentative layout of equipment accom-

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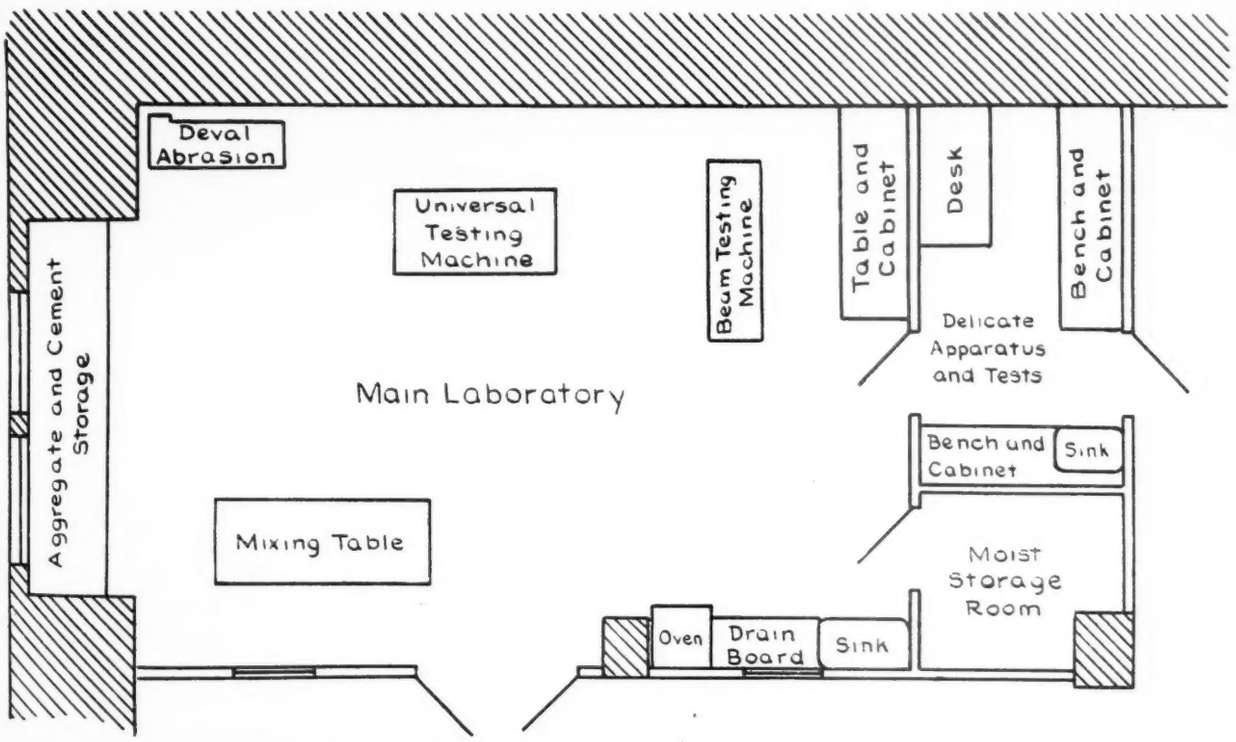

Floor Plan of the Research Laboratory, Showing Tentative Arrangement of Equipment

panies this article, for the further information of our readers.

The policies of the laboratory are controlled by the Committee on Engineering Problems. The principal function of the laboratory will be to study problems of general significance to the sand and gravel industry. This comes from a determination that we, before we can educate the consumer, must equip ourselves with comprehensive knowledge concerning the products of the industry in which we are engaged. When these fundamental truths have been discovered when we are in a position to speak without bias or prejudice, upon the merits of our materials, we shall have performed a real service for the public.

It is fitting to state at this time that the full amount designated as necessary for equipping and running the laboratory for the first year has not yet been realized. It was decided, however, by the Engineering Problems Committee of the Association that the organization should go ahead with the available funds at its disposal for the purpose of getting the laboratory started. It was felt that the results which would be obtained in this manner would soon convince those who have not subscribed to the fund that they owe it to themselves to support the laboratory. It is not too late now for producers to send in their contributions. Full information regarding the basis of assessment will be furnished upon application to the headquarters of the Association, and we look forward to hearing from a great many companies along this line. They should ally themselves with the progressive producers who realize that the sand and gravel industry is a permanent business, and that they must build for the future if they hope to survive.

The extremely rapid growth in the demand for sand and gravel which began when the war debris had been cleared away had the effect of making "production" the principal consideration in the operation of our industry. But a peak must be reached in this demand, and it would appear that it is stabilized now. In the vigorous effort to produce the required amount of material, over-building of plants was soon witnessed. In common with other major industries of the country, the sand and gravel business encountered an era when demand was not sufficient to take care of the existing plants in many sections of the country.

We must turn our thoughts, therefore, to the future. As has been pointed out by Arthur D. Little, science is now advancing at a rate so rapid and with results of such far-reaching influence that no industry can hope to ignore research and live.

Summer follows winter with such unfailing regularity that the ice business would seem to be reasonably secure. But the iceman has now to reckon with the probability that millions of electric refrigerators will be installed within the next two years. Mr. Little urges that American manufacturers must be made to understand that we are in the midst of an industrial revolution, in the course of which many established businesses will find their balance sheets deeply dyed with red unless those charged with the responsibility of management can learn to direct their course in the flood of new knowledge from the laboratories. To those with vision science is bringing countless new opportunities for constructive and profitable effort, while it is likely to take whatever they may have from those who will not see.

The following constitute the membership of the Committee on Engineering Problems: F. D. Coppock (Chairman), Alex W. Dann, John Prince, Hugh Haddow, Jr., H. V. Owens, and R. J. Potts.

Discuss County Road Standards

The standardization of county road building and maintenance methods designed to save millions of dollars annually to the counties of the United States will be the main objective of a national conference of county highway officials to be held at Washington on May 12th. The occasion is the first yearly meeting of the County Officials' Division of the American Road Builders' Association.

The meeting will be held following the general sessions of the American Road Builders' Association on the preceding day. Both meetings will be attended by road officials from every section of the United States.

The meeting will be the first national business session of county highway officials ever held. It will be of outstanding importance because of the fact that the methods for economically spending some $600,000,000 annually for county road building and maintenance will be partially determined.

More than $3,000,000,000 has been expended on the county road systems of the United States during the past five years. Previous to the organization of the County Officials' Division of the American Road Builders' Association, no effort had been made to standardize construction methods to produce the maximum of economy.

Thomas J. Wasser of Jersey City, N. J., president of the County Officials' Division, will preside over the meeting. Plans for the work of committees for the ensuing year will be discussed, and general business procedure will be followed.

Other officials of the Division that will be present at the meeting are: Vice-president Charles E. Grubb of Wilmington, Del.; Vice-president John Kirkpatrick, Benton, Ark.; Vice-president Edward N. Hines, Detroit; Vice-president Stanley Abel, Taft, Cal.; Treasurer James H. MacDonald, New Haven, Conn.; Secretary Charles M. Upham, Washington; and twenty-eight directors. All of the officials are known throughout the field of good roads.

TITANIUM IN BAUXITE ORES AND SLUDGES

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TITANIUM is a well-known component of bauxite ores, sometimes occurring in sufficient quantity to make its recovery worth considering. This question has been raised by some of the companies lixiviating bauxite ores. At the East St. Louis plant of the Aluminum Ore Company, a subsidiary of the Aluminum Company of America, the waste sludge discharged daily contains over 75,000 pounds of TiO_2. The sludge is all through 20-mesh, and a large proportion is slime. A sample of the waste was deslimed so that a gravity-concentration test of the "sand" could be made. The Aluminum Ore Company cooperated in the work and made the chemical determinations.

In order to anticipate the results of table concentration a series of specific gravity fractions (float-and-sink) was made with heavy liquids. Acetylene tetrabromide was used for a density of 2.95, methylene iodide for 3.33, and thallium formate for 3.78, and the double salt of thallium formatemalonate made the separation at 4.20. The fractionation of the original deslimed sample appears in Table 1.

TABLE 1—Fractionation of Granular Bauxite Sludge

Density	Weight per cent	Assay per cent TiO_2	Distribution of TiO_2
Float on 2.95 sp. gr.	22.36	1.9	1.73
2.95 to 3.33	5.40	5.0	1.11
3.33 to 3.78	6.91	15.3	4.33
3.78 to 4.20	19.93	46.4	38.35
Sink in 4.20 sp. gr.	38.61	33.7	53.70
Magnetic	6.79	2.8	0.78
	100.00	24.33	100.00

The investigation showed that the distribution of TiO_2 was not favorable to making a rich concentrate by gravity methods because the best was of intermediate specific gravity—3.78 to 4.20—and had a tenor of only 46.4 per cent of TiO_2. Material that responded to a horseshoe magnet also contained titanium. However, table concentration was tried.

A float-and-sink test of cut 6 was made; the results are shown in Table 3.

TABLE 3—Float-and-Sink Test of Table Cut 6

Density	Weight per cent	Assay per cent TiO_2
Float on 3.33 sp. gr.	0.27	.....
3.33 to 3.90	1.81	27.38
3.90 to 4.08	10.02	43.10
4.08 to 4.28	26.86	45 14
Sink in 4.28 sp. gr.	61.04	31.88
	100.00	37.50

Microscopic examination showed that all the well-known heavy minerals had been liberated by fine grinding. Other tests were made, and all indicated that part of the titanium occurred in forms not commonly known.

If the last three cuts are taken as concentrate, 75 per cent of the titanium would be recovered, but only 50 per cent of the gangue would be rejected; that is, the grade of concentrate would be low—about 36 per cent of TiO_2. A concentrate with a tenor of 36 per cent obtained from a feed that assays 27.60 per cent is not encouraging unless the market has unusually favorable stipulations.

The sample was classified into three spigots and an overflow. It was well known that for precise concentration 10 or more spigots should have been made, but brevity was required.

Spigot 3 was tabled, and simultaneous cuts around the table were taken. The results are shown in Table 2. Cut 1 was taken at the mechanism end of the table and contained the lightest material. Cut 7 was taken at the concentrate end.

TABLE 2—Results of Tabling Spigot 3

No. of cut	Weight pct.	Assay pct. TiO_2	Distribution of TiO_2	Assay pct. waste	Distribution of waste
1	2.11	4.69	0.36	95.31	2.78
2	10.00	3.31	1.20	96.69	13.35
3	24.08	17.38	15.16	82.62	27.48
4	7.45	30.93	8.35	69.07	7.11
5	28.73	36.55	38.04	63.45	25.18
6	26.33	37.50	35.77	62.50	22.73
7	1.30	23.75	1.12	76.25	1.37
	100.00	27.60	100.00	72.40	100.00

The results did not invite commercial tryouts because, as anticipated by the float-and-sink tests, the best cut was of low tenor. Furthermore, for good gravity concentration it is desirable for the economic mineral to be either the lightest or the heaviest, whereas the best products occupy an intermediate position in the fan.

At first thought the mention of titanium suggests ilmenite (including titaniferous magnetite and titaniferous hematite), rutile, and other forms of TiO_2, all of which are heavy enough to yield to gravity concentration, and are recognizable. Other titanium minerals seemed to be present. Hence for further information an examination of other notes was made.

The lighter increment is a good grade of bauxite, and the heavier is chiefly clay with iron, etc. Each contains titanium, which could not be accounted for by a visual examination. It follows that when titanium is found in a mixture of clay and bauxite very little selection is shown; that is, titanium is distributed indiscriminately through the mixture. Some of it is probably in one or both of the little-known minerals leucoxene and xanthitane.

According to Clarke,[1] leucoxene often surrounds ilmenite in the form of a margin of white or even reddish alteration products. This substance is essentially titanite, sometimes accompanied by rutile. In the discussion of the microstructure of micro-

scopic slides of oölitic bauxite Shearer[2] says, "No titanium minerals are determinable in this as in other bauxite slides, although the TiO_2 content invariably ranges from 2 to 4 or 5 per cent. It is most probable that the titanium exists as the alteration product, leucoxene, a whitish, granular, flocculent mineral indistinguishable from the mass of amorphous aluminum hydroxide."

For more than a year the Southern Experiment Station of the United States Bureau of Mines at Tuscaloosa, Alabama, has been making a general survey of bauxite ores. In that work the samples have been sized to make specific gravity separations, the chief aim being to isolate clean bauxite if present. In all, 44 samples have been examined, 14 from Alabama, 8 from Arkansas, 15 from Georgia, 3 from Mississippi and 4 from Tennessee. The titanium content is tabulated below by States.

State	Assay per cent TiO_2
Alabama	2.9
Arkansas	2.1
Georgia	2.6
Mississippi	2.4
Tennessee	2.9

The general average is about 2.5 per cent of TiO_2. Going further with this examination it is found that the titanium is distributed throughout the specific gravity increments. An example is taken at random. The ignition, SiO_2, Fe_2O_3 and Al_2O_3 are also given. The size was between 48 and 100 mesh.

Density	Weight Pct.	Ignition	SiO_2	Fe_2O_3	TiO_2	Al_2O_3
Float on 2.50 sp. gr. ...	15.12	31.7	2.2	2.2	2.4	61.5
Sink in 2.50 sp. gr.....	84.88	21.1	24.6	7.0	3.0	44.3
	100.00					

According to Clarke,[3] xanthitane has been found as a yellow, friable, earthy substance resulting from the alteration of sphene. It is a hydrous titanate of aluminum.

[1] Clarke, F. W., Data on Geochemistry: U. S. Geol. Survey Bull. 695, 1920, p. 344.
[2] Shearer, Harold K., Bauxite and Fullers Earth of the Coastal Plain of Georgia: Geol. Survey Georgia Bull. 3, p. 96.
[3] Clarke, F. W., Work cited, p. 345.

A general distribution of titanium found in bauxite seems to accord with the well known statistical information that the lithosphere has a tenor of 0.77 per cent of TiO_2. Much of it is too disseminated for concentration, the bauxite sludge cited above being an example of its refractory nature.

National Income Increasing

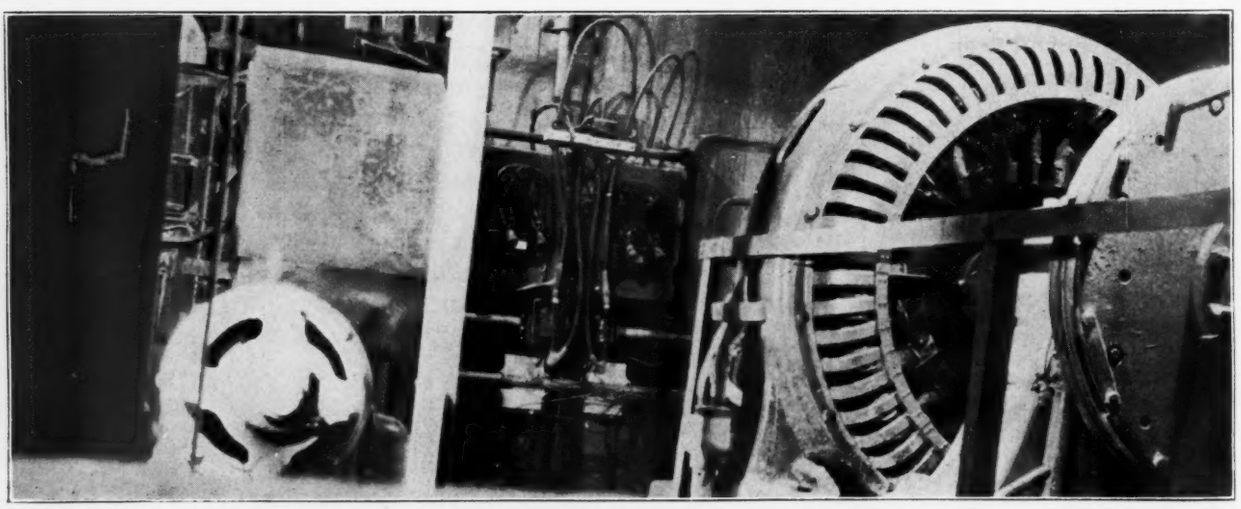
The aggregate national income of the people of the United States totaled almost $90,000,000,000 in 1926, according to figures compiled by the National Bureau of Economic Research. This was an increase of approximately 47 per cent since 1921.

The interesting feature of this survey is the fact that incomes have been increasing on the one hand, while prices have been decreasing on the other.

An Efficient Driving Layout

Two 150 h.p. synchronous motors driving large gyratory stone crushers have been connected to feeders serving other crushers and revolving screens driven by induction motors in a new crushed stone plant. The reason for this combination of different types of motors is to correct the power factor which would be very low if all motors were of the induction type because of the violently fluctuating character of stone crusher loading—when a load of rock is dumped in the load may jump from that of idleness to 400 per cent rated load with some of the crushing units.

The illustration shows one of these 150 h.p. synchronous motors driving the gyratory crusher through a magnetic clutch, the flexibility of which is of value in preventing the motor from being thrown out of step by too sudden changes in load. This clutch is shown at the right and the motor starting equipment at the center of the illustration.



One of the 150 Horse Power Motors Driving Gyratory Crusher

RESEARCH CHECKS DUST EXPLOSION LOSSES

TECHNICAL advances, concentration of manufacturing into larger units, and the more complete utilization of by-products and waste materials, desirable as they may be in industry, are nevertheless, the source of an increasing hazard to industry, through the increase in dust explosions which has followed the changes. At least 28,000 industrial plants, employing more than 1,324,000 persons and manufacturing products of an annual value in excess of $10,000,000,000 are subject to these hazards, David J. Price of the United States Department of Agriculture said on April 25th in an address before the Insurance Department of the Wharton School of Finance and Commerce at the University of Pennsylvania. "Many dust explosions," he said, "are now occurring in industries in which dust explosions have not previously taken place. The introduction of new manufacturing process, as well as new types of mechanical equipment, have added to the importance of dust explosion prevention."

Mr. Price, who is the engineer in charge of chemical and technological research into dust explosions now in progress in the Bureau of Chemistry and Soils, spoke also as the chairman of the Committee on Dust Explosion Hazards of the National Fire Protection Association, and expressed particular satisfaction with the cooperation which he and his staff have enjoyed with the industries, State officials, the insurance agencies, and the underwriters.

"The economic importance of dust explosion prevention," said Mr. Price, "is definitely indicated by the increased attention given to the subject in recent years. Originating as a problem very little understod, surrounded by apparent mystery, it has developed into a project not only of interest to our own country, but commanding considerable attention in foreign countries as well.

"The research work of the Bureau of Chemistry and Soils indicates," he continued, "that when mixed with air in proper proportions combustible dusts of practically all types can be readily ignited by external sources of heat or flame. The bureau has obtained records of more than 300 of these explosions. In 78 dust explosions 498 persons were killed, in 106 explosions 878 were injured. In 144 cases the property loss amounted to $39,706,108, an average of nearly $250,000 for each explosion." These facts, naturally explain the interest of insurance companies and the National Fire Protection Association, composed of 140 organization members and the 4,000 associate members.

This association operates through more than 30 technical committees of which the Dust Explosion Hazards committee is one, each committee having jurisdiction over one section of standard-making activities. This committee has already prepared measures for dust explosion control and prevention in flour and feed mills; in sugar and cocoa pulverizing systems; in terminal grain elevators; in pulverized fuel systems; and in starch factories.

The control measures for mills and elevators were more directly the outcome of the original investigations into these subjects by the Department of Agriculture. The work in starch factories was used by the speaker as an example of the expansion of the work. The hazards of receiving and milling the corn were in large measure covered by the studies of elevator and milling hazards. The special standards for starch factories relate specifically to the handling of dried starch, which the engineers have found to be explosive whenever it is dry enough to float in the air, even though the department may be one in which the air is humid. "These standards," the speaker said, "were prepared by a competent subcommittee composed of engineers from the industry itself as well as fire insurance, State, and Federal agencies."

In its work with pulverized fuel systems, Mr. Price said, "the committee made a distinct departure in that preventive measures were prepared in anticipation of a possible dust explosion hazard rather than waiting for disastrous dust explosions before safety work was undertaken." Regulations for both the indirect and direct systems of utilizing pulverized fuel include standards for (1) location of pulverizing operations, (2) construction of pulverizing building, (3) ventilation and dust collection, (4) operation of pulverizing equipment, (5) installation of magnetic separators, (6) electricity for light and power, (7) grounding of machinery, (8) dust collectors, (9) safety vents, (10) blower installations, (11) drier design, (12) construction of transport pipe lines, (13) location of storage and furnace bins, and (14) fire protection.

"Although the dust explosion hazard now exists in many new industries," Mr. Price said, "it is gratifying to observe the progress in control that has been made in certain of the grain handling industries, particularly in flour milling where the dust explosion loss has been reduced by efficient dust collection systems and other methods of prevention and control. This industry in its early days experienced great loss from dust explosions, but a serious dust explosion in modern flour mills is unusual. When dust explosions do occur in the flour milling industry their effect and extent are limited by efficient control measures."

Mr. Price also discussed studies of the "equally important contributor to national loss," commonly referred to as "spontaneous combustion," the fourth most important cause of the $570,000,000 annual fire loss. Mr. Price said it had been estimated that the annual loss from fires on farms amounts to $150,000,000 or one-sixth of the net in-

come of the farmers in 1924, and that spontaneous combustion of agricultural products and unknown causes takes about $60,000,000 annually. He also referred to the peculiar conditions that followed the floods in Vermont last fall in which hay wet by the floods heated seriously, and mentioned one case in which hay started in a barn heated to the combustion point in about two days and burned the barn while it was still surrounded by three feet of water.

In closing Mr. Price expressed appreciation of the cooperation enjoyed in this conservation of resources, stressed the need for further research, and invited further cooperation.

Intensive Highway Safety Campaign Planned by Road Builders

An intensive highway safety campaign designed to cut down highway accidents which exacted a toll of 141,497 lives during the six years previous to 1928, will be planned during the annual meeting of the American Road Builders' Association which convenes on May 11. A meeting of the County Highway Officials' Division will be held the following day.

It is pointed out by the Association that the accidents are the result of the failure of the human machine rather than errors of engineering or mechanics. The major causes of highway accidents and the estimated number resulting from each during 1927 were listed.

Inattention was the major factor in the killing of 4,584 persons during 1927 according to estimates of the Association. Children crossing or playing in the streets in violation of traffic rules was the second greatest contributor, causing the death of an estimated 3,638 children. Adult jay-walking took a toll of 3,069 lives. The total number of persons killed is estimated at 26,618, and the number of injured at 798,700. During the past six years approximately 3,446,000 persons have been seriously injured in these accidents, and an economic loss suffered estimated to total $3,572,791,000.

Highway accident fatalities caused principally by motorists during 1927 were estimated at 11,765. The causes were as follows:

Inattention	32%	3,765
Speeding	23%	2,706
Traffic Violation	20%	2,353
Intoxication	9%	1,059
Miscellaneous	16%	1,882

Fatalities caused principally by pedestrians were estimated by the American Road Builders' Association to total 11,367. The causes were as follows:

Children playing in the street or crossing in violation of traffic regulation	32%	3,638
Adult Jay-walking	27%	3,069
Inattention	16%	1,819
Confusion	14%	1,591
Other causes	11%	1,250

Fatalities caused principally by physical conditions were estimated by the Association to total 3,486 with causes as follows:

Fog, snow or rain	37%	1,290
Defect in vehicle	19%	662
Skidding	16%	558
Road defect	11%	383
Strong lights	7%	244
Poor street light	7%	244
Confusion in dimming lights	3%	105

The May meeting of the American Road Builders' Association will be partially concerned with a solution of the highway accident problem. It is expected that the officials of the organization will approve a plan to conduct an intensive highway safety campaign using the principles of courtesy and caution as the basis for the movement. In the opinion of the association officials, courtesy and caution are the two main factors in bringing about safety on the public thoroughfare.

Porous Concretes

It is possible to obtain porous concrete of densities between 250 lbs. per cubic yard to 5,500 lbs. per cubic yard, but in practice densities of from 500 to 3,000 lbs. per cubic yard are used. The mechanical strength of porous concrete of a density of 0.1 does not permit industrial application, and porous concretes of densities greater than 1.2 on the other hand, have insufficient insulating power to be interesting. Porous concrete is a light weight insulator, incombustible and stable; its insulating power varies with its density. At equal densities it is as good as cork in insulating power. With decrease in density, its insulating power increases and its strength decreases. Its strength increases with age. It absorbs water only slightly. Water does not penetrate by capillarity, but only by permeating the cement. It becomes wet slowly and then only on the surface. It withstands high temperatures and reheating. It is excellent for sound proofing. Porous concrete advantageously replaces in all their applications as insulators, cork, magnesia, kieselguhr, porous tiles, etc. It insulates equally well against heat, cold and noise. Illustrations of its use as an insulator are (1) Horizontal boilers of oil refineries at Valloe (Norway) where the temperature gradient is 150 degrees C. to 27. (2) Vertical boilers of the Danish factory at Soya. (3) As insulator for an ice producing plant of 12 stages at Hamburg, Germany. (4) Interesting is an application of porous concrete to the insulation of a series of pipelines of several miles carrying steam and hot water for a heating plant in Copenhagen. As an insulator against noise it has given excellent results. A. Mesnager (Science et Industrie and Le Ciment, Nov. 1927).

(Continued from page 62)

mix of gypsum slag concrete were obtained, the age of the cylinders when tested being 30 days:

Specimen	Ultimate Compressive Strength in Pounds per square inch Gypsum Slag Concrete
Armour Inst. of Technology	
1	1030
2	1040
3	1196
Average	1086

In the investigations at Washington University in April, 1926, determinations were made of the ultimate compressive strength of gypsum gravel concrete and gypsum stone concrete. Values of the ultimate compressive strength of gypsum stone concrete were also determined at the tests conducted at the Armour Institute of Technology in April, 1926. A mix of 1½:1:3 was used and the specimens were 6″x12″ cylinders. In these tests at Washington University, the cylinders were tested at the age of 16 days, after having been dried for the first 4 days at room temperature and then for 12 days at a temperature varying from 85° F. to 95° F. In the case of the tests at the Armour Institute of Technology, the age of the specimens when they were tested was 30 days. The results of these tests are as follows:

Specimen	Ultimate Compressive Strength in Pounds per square inch
GYPSUM GRAVEL CONCRETE	
Washington University	
G4	1570
G5	1485
G6	1520
Average	1525
GYPSUM STONE CONCRETE	
Washington University	
S4	1400
S5	1575
S6	1480
Average	1485
Armour Inst. of Technology	
1	1210
2	1250
3	1100
Average	1188

For the same reasons referred to in the previous discussion of the physical properties of gypsum fiber concrete, it has been necessary to determine a value for the modulus of elasticity of gypsum coarse aggregate concrete. Values for this constant were determined from tests made in May, 1925, at Columbia University on 6″x12″ cylinders using a 1½:1:3 mix. The specimens in which stone aggregate were used were tested at an age of 30 days and those in which a cinder aggregate was used at an age of 28 days. The results are as follows:

Specimen	Aggregate	Size of Cylinder	Modulus of Elasticity in lbs. per sq. in.
30,395	Stone	6″x12″	2,570,000
30,396	″	″	2,550,000
30,397	″	″	2,585,000
30,398	″	″	.....
30,399	″	″	2,550,000
Average			2,563,750
30,293	Cinders	6″x12″	1,242,000
30,294	″	″	1,262,000
30,295	″	″	1,194,000
30,296	″	″	1,250,000
30,297	″	″	878,000
Average			1,165,000

Based on the test data given above, gypsum coarse aggregate concrete used in floor and roof construction is required to develop the following minimum ultimate compressive strength in pounds per square inch when dried to constant weight:

(a) 1½ parts gypsum: 1 part sand: 3 parts cinders....600
(b) 1½ parts gypsum: 1 part sand: 3 parts slag.....700
(c) 1½ parts gypsum: 1 part sand: 3 parts gravel....800
(d) 1½ parts gypsum: 1 part sand: 3 parts stone.....800

The safe carrying capacity of floor and roof construction is determined using the following stresses expressed in pounds per square inch:

	Gypsum Coarse Aggregate Concrete		
	Cinder Concrete	Slag Concrete	Gravel or Stone Concrete
Extreme fiber stress in compression in flexure	150	175	200
Modullus of elasticity	1,250,000	2,000,000	2,500,000

From the above table it is seen that the use of the working fiber stress which is recommended in each case as compared with the ultimate compressive strength required gives a factor of safety of not less than 4.

Gypsum Construction

On May 20, 1897, there was conducted for the Bureau of Buildings, New York City, a fire, load, and water test on the poured-in-place suspension construction. The slab consisted of gypsum fiber concrete and was supported on structural steel beams, the size of the test panel being 11′-0″x14′-0″. There was a gypsum plaster ceiling hung from the lower flanges of the beams. The construction was loaded to 150 lbs. per sq. ft. and the fire was then applied continuously for five hours with a maximum temperature of 2100° F. At the expiration of five hours, water at 60 pounds pressure was applied for fifteen minutes followed by a flooding of the top floor with water under low pressure for five minutes. Two days after the fire and water test, the slab was subjected to a load of 600 pounds per square foot. At the expiration of the fire and water test, the ceiling was down in most parts and in some places the material between the beams was washed away so as to expose the wire cables. At the conclusion of the 600 pound load test, the deflection was .26 of an inch. The extremely severe conditions under which this test was conducted should be borne in mind.

Another fire, load and water test was conducted on the poured suspension system at Columbia University on August 15 to 18, 1913, for the city of Toronto. In this test, also, the slab consisted of gypsum fiber concrete supported on structural steel members the size of the test panel being 14′-0″x

14′-0″. The purpose of the test was to determine the effect of a continuous fire lasting three hours at an average temperature of 1700° F., the floor carrying at the same time a load of 125 pounds per square foot. At the end of the three hours, the under side of the floor, while still red hot, was subjected to a 1⅛ inch stream of cold water at 60 pounds pressure for five minutes. The upper side of the floor was then flooded and afterward a stream at full pressure was applied to the under side of the slab for five minutes longer. The superimposed load was then increased to 286 pounds per square foot. Neither flame, smoke, nor water passed through the slab at any time. No appreciable deflection was noted under the initial or working load of 125 pounds per square foot. During the fire, the total deflection of the center of the slab was 9/32 inch. The arch recovered 1/32 inch on cooling. The load of 286 pounds per square foot produced a deflection of 17/32 inch and on release of load the arch recovered until the deflection was 11/32 inch. The severe conditions under which this test was conducted should also be borne in mind.

An idea of the efficacy with which gypsum construction withstands actual fire conditions can be gained by noting the results of a very stubborn fire which started in the building of the Seaboard Warehouse Corporation in New York City on February 17, 1919. This building was of steel skeleton fireproof construction and five stories and basement in height, the area of each floor being eight thousand (8,000) square feet. The walls were of twenty (20) inch and sixteen (16) inch brick and non-bearing except the one on the west side which was a party bearing wall. The structural floors were of gypsum, four inches in thickness, and of the poured Metropolitan system. The floor slabs were supported on structural steel beams and girders, the fire-proofing being of gypsum. The warehouse was used for the storing of such articles as tanning extract; phenol in barrels; sulphur and tobacco powder in bags; wool, hemp, and jute in bales.

When the fire department arrived, the tops of the jute bales were blazing at the rear portion of the first floor. The water which was played on the jute bales on the first floor caused them to expand. This expansion pushed out the north wall of the building a maximum of 3′-4″ at the second floor and allowed the fire to spread to the upper floors. The wall was bowed out from the basement to the roof practically its entire length. The fire burned intermittently for about ten days. During the progress of the fire the sulphur on the second floor was heated or burned to such an extent that it flowed over practically the entire area of the floor to a depth of about two feet.

The load on most floors was between 300 and 510 pounds per square foot before the fire which was an overload of from 150 to 325 per cent. These excessive loads were increased further after the firemen had played the hose streams on the fire. The stock absorbed a great deal of the water.

Concerning the conclusions of the New York Board of Fire Underwriters regarding this fire the following is quoted from their report:

"The floor system performed its function adequately as regards fire-resistance — the floors, panels, girders, and beams resisted the fire well considering the intense heat due to the long continued high temperatures from burning jute and sulphur as well as other merchandise with which the floors were loaded."

It is interesting to note that in the rehabilitation of this building it was found necessary to completely reinstall only several of the floor panels on the north and west sides. The failure of these panels was due to the pushing out of several of the columns which was caused by the expansion of the jute. The remainder of the floor panels were restored by merely patching the under side with plaster. This building is still in use at the present time as a paper storage warehouse by the New York Times.

On December 6, 1922, there was conducted at Columbia University a fire, load, and water test on a pre-cast structural floor slab of gypsum fiber concrete. The construction consisted of a pre-cast floor consisting of 2 inch gypsum floor slabs supported on structural shapes and having ceiling slabs, also two inches thick, hung from the steel channels. The test panel was 14′-0″x20′-0″. A superimposed load of 150 pounds per square foot was placed on the test floor and it was then subjected to a fire test for four hours, the average temperature of the furnace being 1,732° F. The maximum temperature reached in the air space between the upper and lower slabs at the end of the four hour period was only 315° F. Subsequent to the fire test a hose stream at 60 pounds pressure was directed against the ceiling in two periods of five minutes each and the upper slab flooded. The floor slabs were not affected by the fire and water. The ceiling slab was calcined and removed by the hose stream. A short piece of wood which had been left inadvertently between the floor and ceiling slab and which had been there throughout the entire test was blackened only in parts, giving further proof of the low temperature above the two inch ceiling during the test.

In May, 1926, a fire, load, and water test was conducted at Columbia University on a poured-in-place structural floor slab of gypsum fiber concrete. The test panel was 11′-4″x15′-0″. The construction was a composite structure of floor slab and ceiling carried by steel beams. The floor slab was 2½ inches thick and of poured gypsum. The ceiling was 2¼ inches of gypsum, also poured-in-place. The floor was subjected to a continuous fire in accordance with the test requirements of the New York City building code. The highest average tem-

perature reached was 1,891° F. and the average for four hours was 1,732° F. After the fire test, a hose stream was applied against the ceiling in two periods of five minutes each and the floor slab flooded. The floor was then subjected to a load test of 600 pounds per square foot. This construction met the severe provisions of this fire, load and water test and the floor slab and structural framework were unaffected by the fire and water. The ceiling slab was calcined and removed by the hose stream. The average of the maximum temperatures attained on the upper surface of the floor was but 125° F. The maximum temperature reached at the lower flanges of the steel channels was 205° F. The center deflection after the application of water and prior to the application of the 600 pound load was 0.38 inch. The deflection after the load of 600 pounds per square foot had been in place 20 hours was 1.21 inch and after the removal of all load the deflection was 0.38 inch, the same as it was prior to the application of the 600 pound load.

When considering the results of this fire, load and water test, the extremely severe conditions of the test must be borne in mind. After being exposed to a fire endurance test for four hours the same panel was subjected to a hose stream pressure of 60 pounds for a period of ten minutes. That these requirements are too severe is shown by the "Tentative Specifications for Fire Tests of Building Construction and Materials of the American Engineering Standards Committee." These specifications make provision for the application of the hose stream not on the panel which has just been subjected to the fire endurance test but on a duplicate sample which has been exposed to a fire test for a period equal to one-half of that for which classification is desired, but not for more than one hour. Moreover, the hose stream is applied at a pressure of 45 pounds for a duration equal to five minutes for every 100 square feet of exposed area.

As was referred to in the first part of this paper, a full appreciation of the fire behavior of gypsum requires that the chemical properties of the material be taken into consideration. Gypsum ($CaSO_4 . 2H_2O$) has the fortunate characteristic of giving up its chemically combined water of crystallization at temperatures less than 212° F. It is this very important property which gives the product its unique fire resistance. Due to the above characteristic, when gypsum is exposed to the action of fire the water of crystallization is liberated. Calcination begins at the surface exposed to the fire and continues slowly into the construction. It proceeds more and more slowly as time goes on due to the increasing thickness of calcined gypsum on the surface which acts as a barrier or insulator, protecting the uncalcined portion from the fire. At that point in the construction where calcination is in progress the water of crystallization is being liberated, and as it is a law of physics that water cannot be heated above 212° F., so it is likewise impossible to heat gypsum above this temperature until most of the chemically combined water has been evaporated. The practical significance of this phenomenon of calcination is that the temperature of materials protected by gypsum construction cannot exceed 212° F. as long as there is any gypsum present. The behavior of gypsum in withstanding the effect of fire is unique in that no other structural material used for like purpose retards the transfer of heat as it does.

Constant Increase in Importance

The phenomenal growth in the production of gypsum since 1900 and its constantly increasing use in building construction is evidence that it possesses to a marked degree the necessary characteristics for use in modern building construction. Its structural value, its physical properties and its fireproofing and insulation qualities are such that it is rapidly assuming its place as a major building material.

One Cost of Bad Roads

Motorists of the United States pay a bad roads tax equivalent to 22.3 cents on every gallon of gasoline consumed on a poor highway, the American Road Builders' Association stated today. It will cost that much more to consume a gallon of gasoline on poor roads than if the same car were driven on good roads, according to the Association.

The figures were derived from the results of elaborate experiments conducted at Washington State College, Iowa State College, and the North Carolina State College. They are estimated for a car making 10 miles to the gallon on a rough highway.

"On a basis of speed of thirty-three miles per hour," the Washington report states, "the test shows the cost in gasoline and tires per one thousand miles over a certain rough road for an average four cylinder car weighing 3,500 pounds loaded, was $35.10. At the same speed, the cost for the same car over a very smooth improved road was only $12.80."

To attain the highest degree of economy for highway transportation it is essential that road construction methods be standardized in order that roads may be built which will handle traffic at a minimum of cost. An effort is being made to standardize county road construction through a County Highway Officials' Division of the American Road Builders' Association. An important national meeting of this organization will be held in Washington on May 11th, and it is expected to lend much impetus to the standardization of county methods.

A Great Building Project

Announcement was made in Chicago recently of one of the greatest and most interesting of modern building projects—the construction in that city of a gigantic Merchandise Mart to be twice the size of the largest business building in the world. This massive edifice, whose architecture will typify the Great American Building of today, will be two city blocks in length, 18 to 23 stories high, and will represent an investment of $30,000,000. Construction will begin immediately.

The Mart will have a total floor space of about 4,000,000 square feet, as compared with slightly less than 2,000,000 square feet, which is the floor area of the Chicago Furniture Mart—the next largest building. Each of the eighteen main floors will have an area of over 200,000 square feet. The structure will be topped by a five story tower.

This project includes the largest single development of air rights so far scheduled. The property, except for the 553 caissons extending to bed-rock, begins 23 feet above "datum." The site is that of the former passenger station of the Chicago and Northwestern Railway. The building will extend 724 feet on Kinzie street, 577 feet on the Chicago river front and 324 feet on Wells street, with a diagonal frontage facing Orleans and Franklin.

This massive structure will be one of the most imposing masses in the country, according to the architects, Graham, Anderson, Probst & White, and will be set back from the river about eighty feet, and a drive, which will be the start of a North Bank Boulevard, will run between the river and the facade of the building. A river wall of stone, similar to the Wacker Drive walls, will make a stylobate for the whole.

The lower three stories will form a base of stone from which the main structure rises fifteen additional stories, and a broad tower of five stories, not high considering its width of 120 feet, will mark the center of the facade. At the base of the tower will be the main entrance, simple and impressive, flanked by two great bas-reliefs of a heroic scale. These sculptures will be compositions representing the romance of industry and merchandising, and will be of sufficient strength to be admired from across the river. Between the broad pilasters on the facades there will be large show windows for display. In the entire structure there will be a total of 5500 glass windows.

The general shape of the lot is a rhomboid and the angles are turned by having the four street fronts terminate in octagonal towers. These towers, as well as the central tower, also octagonal, are roofed with flat stone roofs, giving a feeling of strength and stability and the three upper stories are terraced back in steps as they butt into the towers.

Entrances on Franklin and Wells streets lead to the main lobby on the center of the river front. The lobby opens up into the many activities and facilities which will greet the buyers of the world and make them at home.

The masonry exterior partly stone will be carried out in a soft grey material with a conservative use of color, and the pier and window relation has been studied to convey to the quick glance of the passerby an appreciation of the colossal character of the project.

Comparison of the cubage of the largest buildings in the world shows the Merchandise Mart will be more than twice the size of the largest business building ever constructed. Here are the figures in cubic feet:

1—The Merchandise Mart, 53,000,000.
2—Chicago Furniture Mart, 25,370,000.
3—Equitable Building, New York City, 24,000,000.
4—General Motors, Detroit, 20,411,000.
5—Union Trust, Cleveland, 20,000,000.
6—Railway Exchange, St. Louis, 18,898,000.
7—Illinois Merchants Bank, Chicago, 17,850,000.
8—Continental & Commercial Bank, Chicago, 13,200,000.
9—Woolworth Building, New York City, 13,200,000.
10—Straus Building, Chicago, 10,000,000.

The big business of the country is now done in concentrated market places, as evidenced by the Garment Center and Cotton Goods Center in New York City, automobile rows in all the leading cities, financial buildings, and the Furniture Mart in Chicago. The establishment of the Merchandise Mart is a dramatic development in the program to make Chicago the Great Central Market, a movement which the Chicago Association of Commerce started a number of years ago.

Labor's Net Increasing

The margin of profit which the industrial workers of the United States earn on their labor appears to be steadily increasing. While weekly earnings of industrial workers in 1925, '26 and '27 averaged 116 per cent greater than they were in July, 1914, the cost of living at the close of 1927 was only 64 per cent greater than in July, 1914. Furthermore, during the last three years wages have shown a slightly rising tendency, and the cost of living a slightly declining tendency. As a result, the purchasing power of the industrial worker's average earnings in 1927 was 33 per cent more than in July, 1914, whereas in 1925 and 1926 it was 28 and 29 per cent greater.

The significance of this tendency from the manufacturer's standpoint is that wage earners appear to have a constantly greater share of their incomes available for purchase of merchandise outside of the strictly necessity class—that is, automobiles, radios, amusement, electrical equipment, and the like.

ABSORPTION IN SLAG AND SLAG CONCRETE*

THIS Symposium is one of a collection pertaining to characteristics and uses of blast furnace slag. It covers absorption tests conducted on concrete cylinders, plain and reinforced; concrete brick, tile and block; powdered slag admixtures in concrete; slag-lime brick and stone; and comparative absorption tests with gravel, crushed stone and slag, giving the results of different tests both as to absorption per cubic foot by volume and weight and the percentages of absorption. It also includes comparative tests of the absorption of bitumen by slag.

It is noted that all the water calculated to have been absorbed by slag does not actually enter the slag as part of it is retained in the viscular openings on the surface of the slag and is not removed by towels in preparing the samples for testing. This water would have no effect in breaking down the structure under frost action. The same truth may be applied to the sodium sulphate test as slag usually stands more cycles than the average aggregate.

Slag is at a disadvantage, when absorption tests are given in percentages as it weighs much less than stone or gravel and an equal weight of water absorbed by stone, gravel and slag would result in a much higher percentage of absorption for slag although the volume of water may be the same. This point is proved clearly in the results of tests by Dr. C. E. Bardsley at the Highway Materials Testing Labroatory of the Michigan State Highway Department which included absorption figures on a limestone graded 1½ to 3 inches and two slags —one graded 1½ to 3 inches and the other ⅜ to ½ inch. The following table shows that the limestone absorbed more water than either of the slag samples:

Kind of Aggregate	Specific Gravity	Absorption of Pounds per cubic foot	Aggregate Percentage by weight
Limestone	2.52	5.44	3.47
Coarse Slag	2.12	5.23	4.03
Fine Slag	2.40	5.36	3.58

A summary of the results of tests conducted by the United States Bureau of Public Roads is contained in bulletin 370 by Prevost Hubbard and Frank H. Jackson which gives absorption tests on 30 slags. The bulletin contains the data on 3650 rock samples, which show that there are a number of aggregates with a higher absorption factor than slag, ranging from a rock with .08 pounds to one with 14 pounds of water absorbed. The highest slag absorption figure, 4.90 pounds, was surpassed by samples of limestone, basalt, dolomite, sandstone, chert, rhyolite, adesite, serpentine, breccia and tuff, while the lowest slag figure, .04, was less than shown by any rock sample. Tests for the physical properties of slag were carried out according to the method described in bulletin 370 in the testing laboratory of the Ohio State Highway Department. Slags from Pennsylvania and Ohio, which were reported by A. S. Rea were used. These resulted in high absorption factors for a number of slags.

It seems evident from the data compiled by Fred Hubbard from tests made at the laboratory of the Standard Slag Company that the above slags were selected in order to show extreme values. The latter tests were in accordance with bulletin 1216 of the United States Department of Agriculture which provides for a 1000 gram sample being dried and immersed in water for 24 hours. This showed considerably lower absorption tests as published in "Test Data on Slag."

In "Wear Tests of Concrete," presented by Duff A. Abrams to the American Society for Testing Materials, he gave the results of tests at the research laboratory of the Portland Cement Association. He found the absorption tests on 13 slag samples averaged 2.2 per cent by weight or 3.2 pounds of water absorbed by one cubic foot of solid material.

In an article "Toughness of Bituminous Aggregates," Journal of Agricultural Research, Vol. 10, No. 7, Charles Reeve and Richard Lewis report a blast furnace slag sample with a specific gravity of 2.89 which showed an absorption of 1.18 pounds of water per cubic foot of material or .65 per cent. Physical tests on slag at the Columbia University were reported in a booklet "Slags for Building" which showed an absorption figure of 2.81 per cent or 4.59 pounds of water absorbed by one foot of material. The freezing and thawing tests by Edward Orton necessitated the saturation of slag samples. Four samples were soaked 8 days but readings taken at different periods showed that they absorbed almost as much water in three hours as during the entire eight days.

Henry Gilg described an absorption test on pressed slag brick. The brick was made by mixing air cooled slag, granulated slag and water into a plastic mass, and pressing out the bricks. They were hardened by exposing to hot chimneys for 40 to 60 hours. They were dried for three hours at 570 degrees Fahr., cooled to ordinary temperature and soaked in water for three hours, which showed an absorption factor of 14.5 per cent. Similar brick were indurated by steam. They were dried at 212 degrees Fahr. and immersed for 24 hours. One sample showed 5.07 and the other sample showed 5.71 per cent absorption.

In the booklet "Blast Furnace Slag," 1921, the Carnegie Steel Company calls attention to the low absorption without giving specific figures. Car-

*Abstract of Symposium Number I, Collection of Data concerning Absorption and Moisture, prepared by the National Slag Association for presentation to its members.

negie Steel Company has constructed numerous buildings partially or wholly of slag concrete for its own use which testify to its faith in recommending slag as a building material.

V. R. Sarstedt expresses a different opinion when he discusses the proportioning of slag concrete. He states: "The proportioning should be the same as in stone or gravel except that it requires considerably more water. Slag absorbs more water than any other material."

Large quantities of slag are used in tar-macadam construction on main highways in England and the absorptive properties are of interest. George Ward gives the following opinion: "Whereas a porous aggregate like limestone or slag will absorb the volatile oils of a thin tar and leave a more viscous binder for coating its surface, none of this absorptive power lies with a granite."

Tests made by the baking and boiling method of the American Society for Testing Materials were reported by the Concrete Materials Company of America. The concrete samples of 1:2:3 mix were baked at 230 degrees Fahr. for three hours, cooled to room temperature, and boiled for five hours after which the absorption is figured on the dry weight. Seventeen samples of slag concrete pipe and nine of gravel concrete were tested. The slag concrete samples averaged 6.5 per cent absorption and the gravel concrete 5.8.

The Better Brick Company, which uses granulated slag as coarse aggregate, states: "The proportions used in making the brick and tile are one cement, two of sand and three parts of granulated slag. Tests made on the product show strength equal to that of clay brick with the absorption running from 7 to 10 per cent, for the colored brick, to 18 per cent for the common brick."

Stanton Walker and E. W. Dienhart have subjected about 400 specimens of common brick to physical tests, among which were some absorption tests. The aggregates were blast furnace slag, pebbles, limestone and cinders in combination with sand. Absorption tests were carried on at the Lewis Institute with the following results:

Kind of Aggregate	Weight in pounds	Absorption of Concrete Pounds per cubic foot	Per cent by weight
Sand and Pebbles	4.8	6.9	5.7
Sand and Pebbles	4.9	7.2	5.7
Sand and Coarse Slag ...	4.7	7.4	6.1
Sand and Cinders	3.9	7.7	7.8
Sand and Cinders	4.0	7.9	7.7
50 % Sand and 50 % Slag	4.6	8.4	7.1
33% Sand and 67% Slag..	4.3	8.4	7.7
67% Sand and 33% Slag..	4.4	9.2	8.1
Sand and Pebbles	4.4	10.5	9.3

Prof. Duff A. Abrams, conducted tests to determine the effect on concrete of varying percentages of various admixtures, one of which was powdered granulated slag. The coarse aggregate was gravel and the amount of admixture varied by volume 5, 10, 20, 33 and 50 per cent. Absorption values were given as the average of all percentages in a 1:4 real mix. Concrete containing the slag showed the lowest absorption, 2.66 per cent. Dalton G. Miller investigated the effect of admixtures in concrete with particular reference to its life in sulphate solution to discover something that would assist in preventing the disintegration of concrete drain pipe in alkali soils. The test specimens were gravel concrete cylinders. The absorption of cylinders containing slag were 5.44, 5.60, 5.48 and 5.58 per cent.

From the reports of investigations as abstracted, it is concluded that neither slag nor slag concrete has a greater absorption rate than the majority of aggregates and concretes in general use. This conclusion is based largely on the action of the Carnegie Steel Company which uses slag for construction purposes, including water towers, standpipes, boiler stacks, warehouses, residences, office buildings and mill buildings. In the booklet "Blast Furnace Slag," the Carnegie Steel Company states concerning slag: "Its closed cellular structure prevents penetration by water as is evidenced by its very low absorption ratio. This is a very essential feature when permanency is desirable as in office and mill building work."

Pure Alumina from Clay

Pure alumina is obtained from alumina containing silicon, iron, ferrosilicon or oxides of iron, by treatment with chlorine or hydrochloric acid gas at a temperature above 200 degrees C. Reducing agents may be used, carbon may be added to the alumina or carbon monoxide may be mixed with the gases. Volatile silicon tetrachloride and ferricchloride are removed, leaving the alumina in a loose brittle form which can easily be ground. The impure alumina is formed by heating clay and carbon in an electric furnace and separating the alumina from the bulk of the ferro-silicon formed by reduction. The mixture of clay and carbon may first be treated with coal gas at 900 degrees C. to reduce the iron. Z. H. R. Kenkyiyo; Japan (British patent 284,661).

A New Lime Kiln

The kiln consists of a jacketed, inverted semi-ellipsoid. The calcium carbonate is introduced together with pulverized fuel through a nozzle at the bottom, sprays over the interior and the burned lime drops into a trough surrounding the nozzle. The gases are conducted away through outlets at the base of the combustion chamber. The combustion air is introduced through the top of the jacket which connects with the air blower, thus undergoing preheating. A. Denisch (German Patent 454,402).

PIT AND QUARRY FOREIGN DIGEST

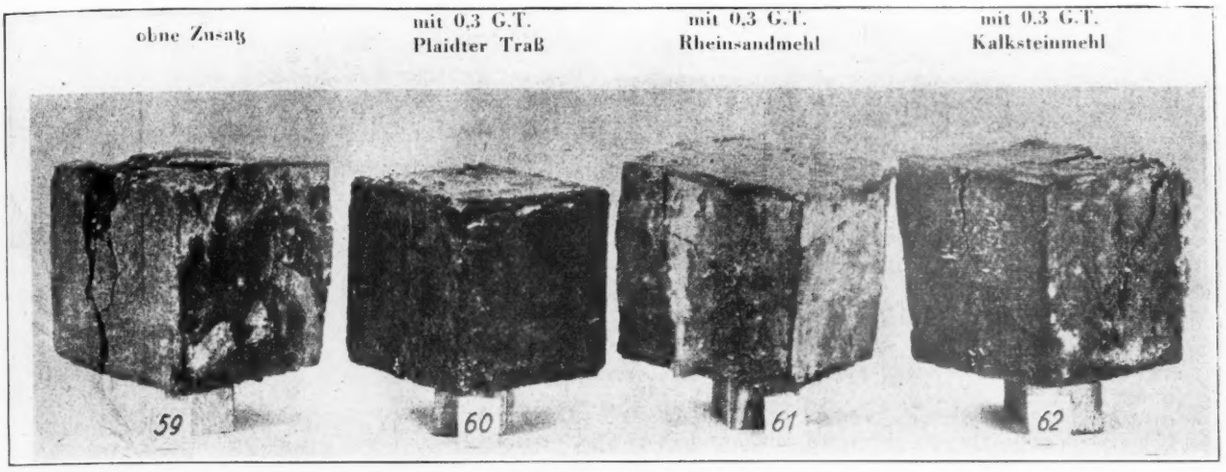


Figure 5—1 Day in Damp Air, 6 Days Under Water, Then 9½ Months in Magnesium Chloride Solution, 20 Degrees Be.

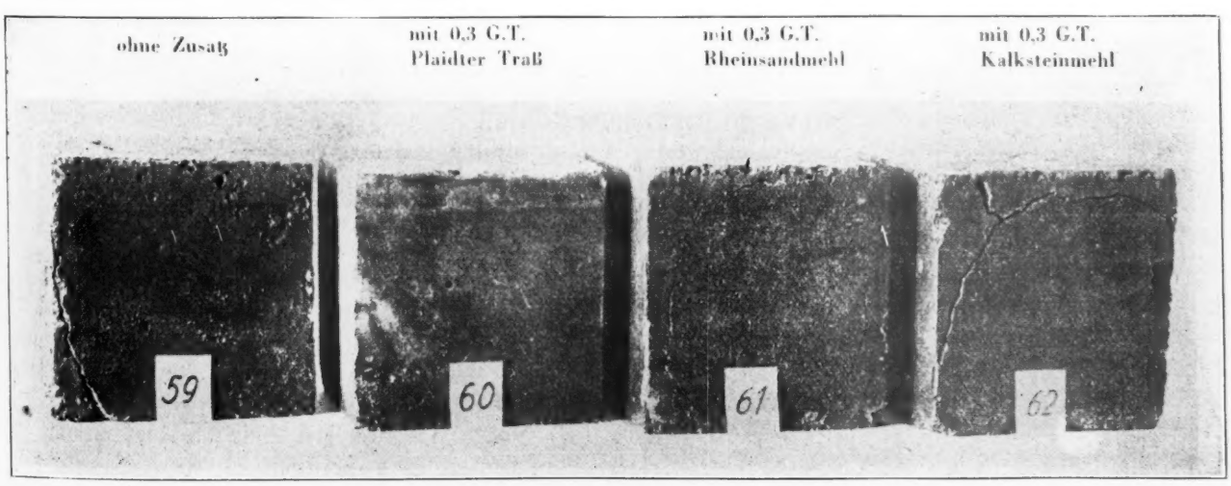
Trass and Cement Mortars

An investigation was made upon the influence of ground trass and other ground stones upon the tensile and compressive strengths, the permeability to water and the resistance to chemical attack of cement mortars with the following results:

That the effect of ground trass or limestone in increasing the strength of cement mortars involves the increase in density of the mortar due to the addition of these substances. Rich concretes as a rule show no increase of crushing strength because there is usually no increase in density with these concretes. With lean mortars and concretes very considerable increase in strengths take place upon such additions. Its value depends upon the amount of ground stone introduced. The crushing strength of mortars are increased by the addition of ground trass (from Plaidt) or ground sand (from the Rhine) if the mortar lacks very finely divided aggregate. Small additions cause an increase, large amounts a decrease in strength (Figures 1 & 2). Mortars with a good grain size composition do not undergo a decrease in permeability to water through additions of ground stones. Other results show that permeable mortars or concrete which lack the finely divided aggregate are rendered less permeable by the addition of trass meal. Furthermore, trass increases the adhesiveness of the mortar. Trass raises the resistance of cement mortars to the action of magnesium sulphate and magnesium chloride solutions. Limestone flour decreases it. (Figures 5 & 6). Otto Graf. (Zement, March, 1928).

Concrete in Non-Cubical Specimens

The strength of concrete test pieces is dependent very largely upon the measurements of the pieces. The less their height, the area being constant, the greater strength values will be found. A series of tests were made with standard mortars on sections of the German standard cubes whose heights were varied from the usual cube down to about 12% of this size. With decreasing height the strength observed increased to a maximum of more than 2½ times that of the standard sized cube. B. Garre (Tonindustrie Zeitung).



Curing: 1 Day in Damp Air, 6 Days Under Water, 35 Days in a Dry Room, Then 5½ Months in Magnesium Solution of 20 Degrees Be.

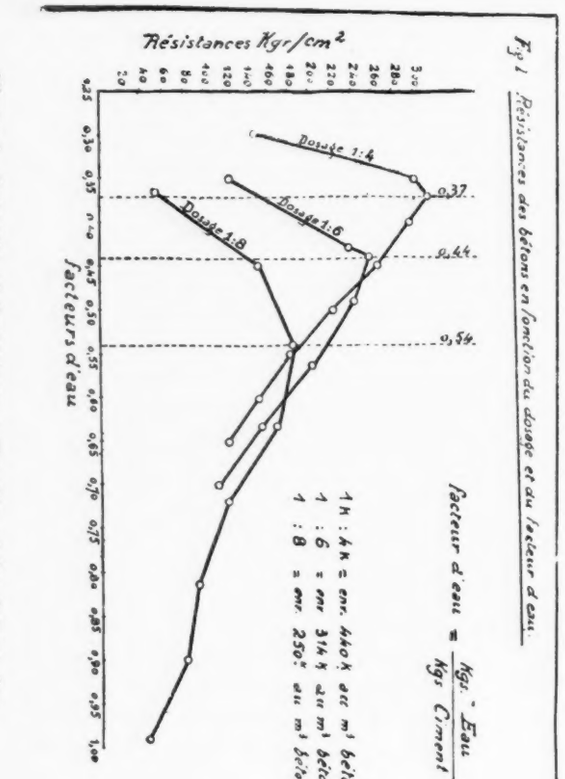


Figure 1—Strengths of Concrete as a Fraction of the Cement Content and Water Ratio

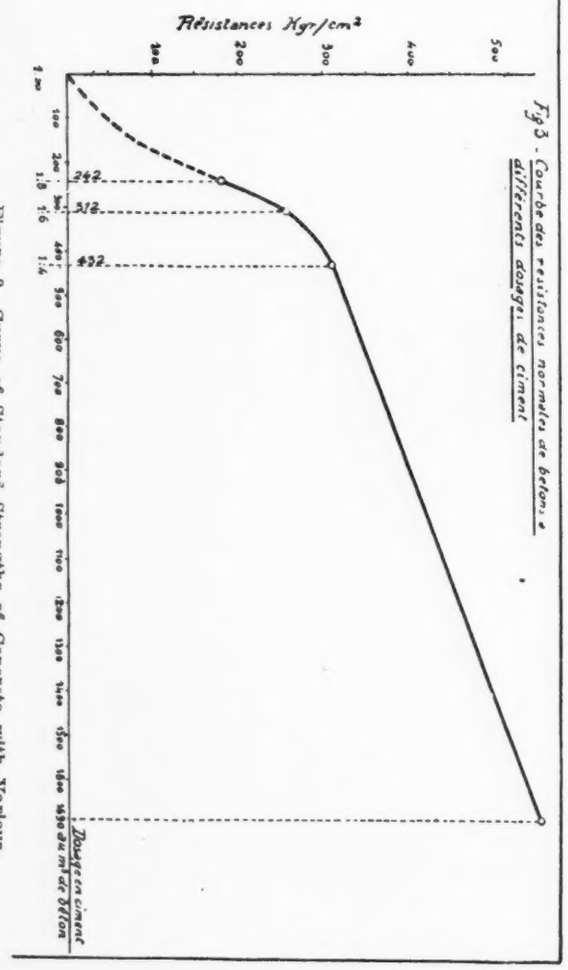


Figure 2—Curve of Standard Strengths of Concrete with Various Proportions of Cement

Structure of Cement Constituents

Strontium and barium were found to give "Alites" similar to the calcium alite. Alite and Belite were given the following structures as a result of further investigation:

Alite

```
Ca - O - Ca    Ca - O - Ca
 ‘              ‘
 O              O      O
 ‘              ‘      ‘
Al - O - Si  - Si - O - Al
 ‘              ‘      ‘
 O              O      O
 ‘              ‘      ‘
Ca - O - Ca    Ca - O - Ca
```

Belite

```
Ca - O - Ca    Ca - O - Ca
 ‘              ‘
 O              O      O
 ‘              ‘      ‘
Si - O - Si  - Si - O - Si
 ‘              ‘      ‘
 O              O      O
 ‘              ‘      ‘
Ca - O - Ca    Ca - O - Ca
```

Mixed crystals are therefore possible between Alite and Belite, as shown by x-ray photographs. Alite is —4 CaO Al_2O_3 Fe_2O_3. Alite plays the decisive role in the setting of cements, while Belite does so during the hardening. Prof. Dr. E. Jaenecke (Special Report General Meeting German Portland Cement Mfrs., Berlin, March, 1928).

Testing Portland Cement and Concrete

It is important that each test comprise the breaking of several sample pieces made from the same batch, in order to obtain an average value which will eliminate a single abnormal figure. It is indispensable to make the following laboratory tests simultaneously: (1) On neat cement and standard mortar after the standard strength tests. These give the most comparable results and which alone permit the builder to judge the quality of the product furnished: (2) Tests on concrete made in the laboratory with the same materials and proportions used in practice. The strength of these test pieces compared with those made in the field will tell how to use the cement in practice and to learn if the full value of the cement is being utilized. A concrete well made, having a strength of 4,000 lbs. per sq. in. with 7% water, that is a water-cement ratio equal to 0.53 gives a strength of about 66% of that of a 1:3 standard mortar. Finally, it is fundamental, if different brands of cements are to be compared, in order to make effectual tests, identical conditions must be observed either in the laboratory or field. Figure 1 shows the relations between the cement-water ratio (abscissa), and the strength in kg./sq. cm. (ordinates). Figure 2. the relation between the strength of standard concrete and different proportions of cement. Dugardin. (Le Ciment, March, 1928).

Grinding Portland Cement

Hollow grinding-bodies for use in tubular mills for fine-grinding Portland cement are made of steel by forging, pinching or pressing, and are prismatic in shape with the edges and corners sharp or rounded. They may be closed at one end and their length should not exceed their greatest width. The cross-section is a polygon of regular shape. O. Kordt; Germany. (British Patent 284,580).

Compression Tests on Concrete

The Building Research Board of London has investigated the effect of the end packing used in making the test for compressive strength of concrete and finds that the influence of the type of packing used is considerably greater than is generally suspected. This factor does not, of course, affect the real strength of the material, but the varying amounts of frictional constraint on the end faces of the specimen induce stresses of unknown magnitude, and these may appreciably alter the apparent strength results. The table illustrates this point. Each value is the average of 15 tests upon 1:2:4 concrete cylinders 6 in. high and 3 in. diameter. The water content was controlled as accurately as possible by means of flow table tests, and other conditions were kept as constant as possible, the only variable being the type of packing.

Type of Packing	Apparent Crushing Strength Lbs. per sq. in.	Observed Angle of Fracture (Degrees)
Plywood	2,268	56.8
Millboard	2,032	58.7
Carpet felt	1,872	59.1
Steel Plates	1,860	60.3
Lead	1,642	60.9
Ruberoid	1,628	61.2

The effect of non-parallelism can be minimized by the employment of a ball either at one or both ends of the specimen. (Concrete and Const. Eng. (London) April, 1928).

Composition of Alite

The formula 8 CaO . SiO_2 . Al_2O_3 for alite proposed by Jaenecke is far from certain, for several reasons. The optical identification of alite is extremely difficult, and moreover, in the electric arc where it is supposed to form, the temperature is high enough to fuse CaO and produce mixtures of CaO, SiO_2 and Al_2O_3 in various proportions without the formation of definite compounds. More important is the difference in percentage composition attributed to alite and to Portland cement. With the per cent of alite said to be in Portland cement and with the composition 8 CaO . SiO_2 . Al_2O_3, the remaining components would have to have an improbable composition in order to make the integral composition of the cement agree with analyses of the latter. A. Rebuffat (Giorn. chim. ind. applicate **9**, 520, and Chem. Abs.).

Concrete and Chemical Attack

The chief causes of concrete failure, other than mechanical, are chemical such as water containing sulphates or NH_3 salts, or free CO_2, etc., which act vigorously on concrete. So-called free lime may be formed on setting and injure the concrete. For greatest resistance to chemical attack, the concrete must be water tight. Where great resistance to chemicals is required, a cement low in lime; i.e., aluminous cement should be used.

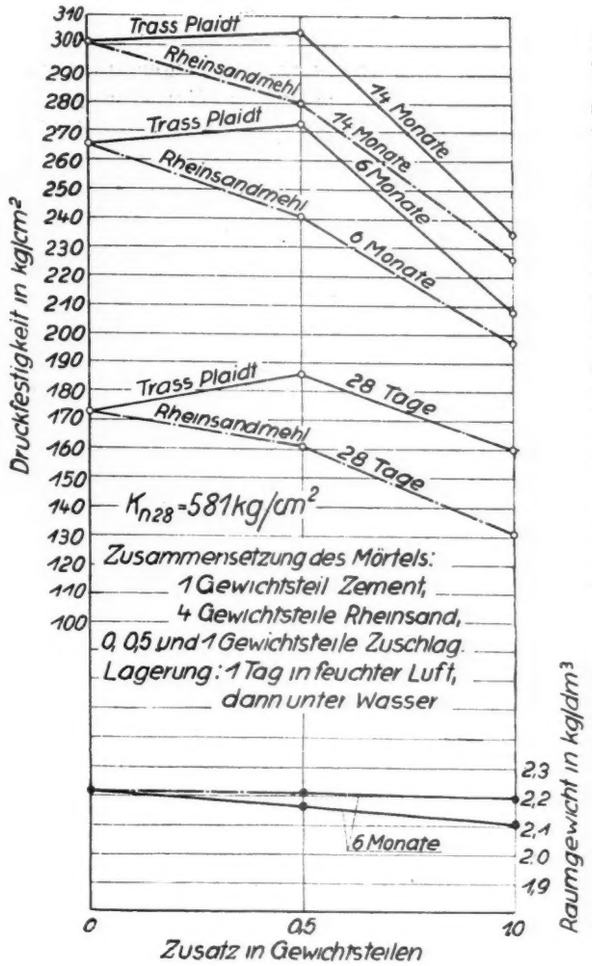


Abb. 24
Flüssig angemachte Mörtel mit Sand Z; Gruppe IV
(Kornzusammensetzung nach Abb. 22)

Figure 3—Composition of Mortars, 1 Part Cement and 4 Parts Rhein Sand After 1 Day in Damp Air and Remainder of Time in Water

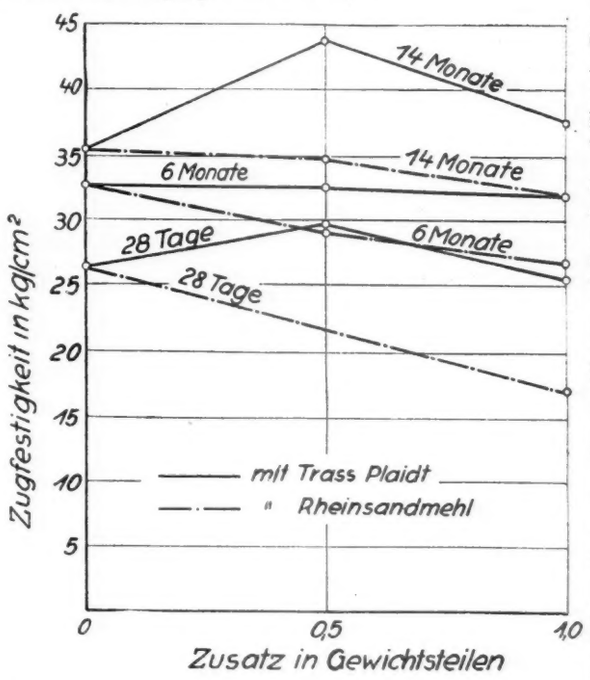


Abb. 25
Zugfestigkeit der flüssig angemachten Mörtel mit Sand Z; Gruppe IV
(Kornzusammensetzung nach Abb. 22)

Figure 4—Tensile Strength After 1 Day in Water, and Remainder of Time in Damp Air

(Continued from page 74)

In the University of Texas rattler test, the test specimen is a concrete ring 28 inches in outside diameter with 20 inches inside diameter and 8 inches in breadth, which is placed in the cylinder of the rattler. The charge, consisting of 158 pounds of cast iron, which is in the form of bars and cubes with the corners rounded, is placed inside the concrete ring and two heads hold the specimen in place while the machine is rotated 1000 times. The losses in weight, in percenage, showed slag concrete 2.3 per cent; stone concrete average for 11 samples 3.5 per cent; and gravel concrete, for 6 samples, 3.9 per cent.

The Arlington Circular Track Test consisted of a track 625 feet in circumference and 4 feet wide, constructed in 62 sections approximately 10 feet in length. Ten of the sections were stone concrete, nine gravel, five blast furnace slag and three sections smelter slag concrete. Two solid rubber tired truck wheels, each loaded to 3000 pounds were mounted in a frame and run over the track 55,000 times, then the tires were equipped with chains and an additional 25,000 runs were made. The average for the ten stones was .46 inches depth of wear; for the nine gravels .31, and for the three slags .37 inches. The best slag concrete, with a wear of .27 inches, made about the same showing as the best stone and gravel.

The data presented in the symposium, according to the author, prove beyond doubt that it is entirely feasible to use blast furnace slag in strucures subject to abrasion and wear, with the expectation that equally good results will be obtained as with other aggregates.

Among other authorities quoted and tests cited the author quotes from an article, "Putting Slag to Work," published in the Scientific American, July. 1925.

"The past few years has brought about proof of the ability of the material to stand up under the most severe traffic punishment in sections of the country where the climatic conditions were exceptionally severe" and from the same article, "Prior to 1922, eastern cities, particularly New York, Washington and Philadelphia, laid hundreds of thousands of yards of slag blocks whose wearing qualities place them in a category of their own. Wear is practically nil. With the exception of rare cases, of slight chipping at the joints, the effect of traffic abrasion on these blocks after twenty years service is not measurable."

It Is Fine

M. D. Tilson, president and manager of the Texas Sand Company, Texarkana, Texas, writes; "We received your 1928 Hand Book. It is fine. Thanks."

Capital and Credit Increasing

The extent to which our supply of capital and credit has been increasing in this country is illustrated by the total of new capital flotations offered in the United States in 1927. The grand total of corporate, foreign government, farm loan, and municipal financing for the year stands a t $9,870,-894,090, as compared to $7,430,274,684 in 1926, $7,-126,023,683 in 1925, $6,352,470,987 in 1924 and $4,-989,745,599 in 1923. In short, the total was over $2,000,000,000 more than that for 1926 and practically double that of 1923. Foreign issues, which are included in the above figures, also show a remarkable increase. The total for 1927 stands at $1,-718,796,425 as compared to $1,349,793,040 in 1926, and only $343,026,279 in 1923.

If it is true that in 1927 over $2,000,000,000 of issues were for the purpose of refinancing; but even if we subtracted these from the total, we find that the remaining amount of new capital issues in 1927 were greater than the total of both new capital and refunding issues in 1926.

One reason for the large size of the total in 1927, of course, has been the fact that corporations, municipalities and governments took advantage of low interest rates to accomplish financing upon as economical a basis as possible. If interest rates advance somewhat in 1928, as appears not at all unlikely, the upward trend of new capital flotations may be somewhat checked.

Forty Story Buildings to Be Common

The day of the super-giant skyscraper has dawned, according to the Indiana Limestone Company.

"Skyscrapers towering forty stories and more will become a common sight if plans already made in some sections of the country are carried out. Construction of several office buildings rising sheer seven and eight hundred feet in the air have been announced recently," according to a statement issued yesterday by the company.

"America's skyline has been rising steadily. A few years ago a twenty-story building was a staggering thought. Today our latest and most modern commercial buildings make our first skyscrapers look like architectural dwarfs. In the early days of the nation's commercial progress 75,000 cubic feet of stone would fill the requirements of a building of substantial proportions. Last year one building alone, the New York Life Building, required 450,-000 cubic feet of stone. It is estimated that some of the skyscrapers projected this year will cost between $30,000,000 and $40,000,000.

"The economic condition of the country is favorable for this large scale construction. There is no sign on the horizon of any lack of funds for the financing of these colossal projects.

INTIMATE NEWS OF MEN AND PLANTS

Bedford Stone Company to Enlarge Plant

The Bedford-Carthage Cut Stone Company plans to enlarge its plant at Cisco, Texas, according to Secretary Peters of the Cisco chamber of commerce. Negotiations are now under way for additional land along the M. K. & T. Railroad right of way. Details will not be announced until the negotiations have been completed.

Metalloid Corporation to Enlarge Plant

The Metalloid Corporation of 53 West Jackson Boulevard, Chicago, Illinois, plans to expend $300,000 in the next two years in improvements and extensions to its mineral drying and grinding plant at 700 West Third Street, Pueblo, Colorado. New Machinery and equipment for the preparation of non-metallic minerals will be installed.

New Indiana Stone Merger

The third large stone merger of the Indiana belt was recently completed when the Shawnee Stone Company of Bloomington, the Oolitic Stone Mill of Bloomington, the W. R. Mahan Mill of Chicago, and the Mahan Company, a sales organization of Chicago, were united to form the new Shawnee Stone Company. The holdings of the merged company amount to several million dollars. First mortgage bonds for $700,000 will be issued to pay for properties acquired and for additional operating expenses.

The general administrative offices of the new merger will be in the Citizens Loan and Trust Company building, at Bloomington, the estimating and drafting office will be in the office building recently completed at the Central Stone Mill in Bloomington, and the sales offices in Chicago and New York. Officers of the company are: J. L. Torpsy, president; W. R. Mahan, vice president; and F. W. Wasmund, secretary and treasurer.

U. S. Gypsum Purchases New Plant

The United States Gypsum Company recently purchased the plant and holdings of the Northwest Gypsum Company at Gypsum, about nine miles southeast of Lewiston, Montana. Final negotiations were made by T. H. Kassner, in charge of operations at Chicago, and F. B. Gibbs, sales manager of Minneapolis, representing the United States Gypsum Company, and Ray M. Calkins, president and general manager of the Northwest Gypsum Company. The new owners some years ago acquired large holdings adjacent to this propperty and combined they will comprise one of the largest deposits under one operation in the country.

Oil City to Get New Plant

The Oil City Sand and Gravel Company, formerly the Allegheny River Sand and Gravel Company, plans to move from its old plant at West Hickory, Pennsylvania, to a new location at Alcorn Island, north of Oil City. The company has been recently reorganized with a capitalization of $100,000 and will be under the management of Captain Charles A. Smith of Blawnox, with offices in Oil City. Equipment will be moved to the new plant as soon as possible, and the initial output will be about 2,000 tons daily.

English Quarrymen to Meet

The Institute of Quarrying, with offices at 160 Edmund Street, Birmingham, England, will convene its Annual Conference at Blackpool, June 4-9, 1928. The exhibition of quarrying and construction equipment will be open from June 2 to 9 inclusive. Among the papers to be read at the Conference the following have been listed: "Sand and Gravel Washing," O. Rickoff; "Commercial Silica Sands," W. J. Rees; "Silica, Commercial Properties and Markets," P. G. H. Boswell; "Belt Preservation and Maintenance," James H. Cooke; "Some Technical Aspects of Lime Burning," C. Wood; "Kiln Design," E. L. Johnson; "Freestone Quarrying," to be arranged; C. H. D. Dawson; "Modern Blasting Methods," W. Cullen; "Cutting Costs in Slate Quarries, Blocks and Waste," T. R. Druitt, and "Electric Traction in Quarries," J. Williams-Ellis.

New Plant for Moundsville, West Virginia

The Moundsville Sand and Gravel Company of Moundsville, West Virginia, was recently granted a permit to erect a $50,000 plant in that city at a meeting of the city council. The new plant is to be located just north of the Little Grove creek, and the building, which is now under construction, will be completed by the middle of the summer.

New Cement Plant for Arkansas

The Arkansas Portland Cement Company has begun the erection of a $2,000,000 cement plant, near Saratoga, Howard County, Arkansas. A four mile spur is to be built from the main line of the Nashville, Graysonia and Ashdown Railroad to transport the product and a four mile highway is being constructed to join the Saratoga, Mineral Springs Highway.

The Arkansas Portland Cement Company, controlled by Ada, Oklahoma capital, has acquired large limestone deposits in Sevier, Little River and Howard Counties. M. O. Matthews, vice-president of the company, will be in charge of the new plant and Paul C. Vanzandt is chief engineer in charge of construction.

New Company Takes Over Clayton Pits

The Clayton Sand and Gravel Corporation, of Clayton, New York, which was formed in January, has taken over all the properties and the sand and gravel business of Bogenschutz Brothers. The new organization has purchased other pits at Watertown, New York.

A 20 car siding has been laid from the New York Central lines to the Clayton plant. The material is taken from the pit by a Beaumont slack line to the Link Belt washer and grader and by gravity to the bins on railroad siding. The new company has recently purchased a Thew shovel mounted on a caterpillar tractor and equipped with an Owen clamshell.

Sand Company Buys Dunes

The Hubbell Sand Company of Manistee, Michigan, has contracted with that city for the purchase of large sand dunes in Fifth avenue park at 2½ cents a ton. The company already owns dunes to the south and north of the city property and proposes to remove all of these within the next 25 years.

Structural Gypsum Moves to New Offices

After April 28, 1928 the executive, engineering and general sales offices of the Structural Gypsum Corporation and the Gypsteel Construction Company will be located at their new plant at Linden, New Jersey. The New York sales offices will remove to 535 Fifth Avenue, New York City.

Universal Granite Moves

The Universal Granite Quarries Company has moved its offices from 133 West Washington Street, Chicago, to the Conway Building, 111 West Washington Street. It occupies suite 1939 and the telephone is Franklin 1293.

Large Stone Quarry Blast at California Plant

One of the largest blasts ever exploded in Southern California was ignited at the plant of the California Portland Cement Company at Colton on the morning of April 1, under the direction of A. H. Clough of the Giant Powder Company. E. E. Duque, general manager of the company, said that about 95 tons of explosives were used and estimated the amount of rock broken off by the blast, which was of the bank variety, at about 750,000 tons. In order to place the charge two separate tunnels were bored into the face of Slover mountain. One of them extended 73 feet and branched out at its inner extremity 102 feet to the east and 95 feet to the west, the other was 72 feet long and branched out 112 feet east and 165 feet west. The inner face of the section dislodged by the blast was 504 feet long.

Talc Property to Be Opened

Operations on the property of the newly organized Skagit Talc Mining and Refining Company located about 4 miles northeast of Sedro-Woolley, Washington, will be begun during the early summer, according to Jack Davidson, president of the company. Initial activities include the construction of 2 miles of track to transport the talc to the railroad. Mr. Davidson's headquarters are in Seattle.

Oregon Lime Plant Crippled by Rock Slide

The Lively Lime Products Company of Gold Hill, Oregon, recently suffered severe damage through a slide of several hundred tons of rock caused by the recent heavy rainfall. Fortunately the slide came at night and there were no casualties. Clearing up of the slide was immediately begun and operations will soon be in full force.

Mariana Lime Leases Valuable Deposit

The Mariana Lime Products Company of Mariana, Florida, has leased the limestone deposits at White Cliffs, Little River County, Arkansas. The lease is for 99 years and plans are being made to begin production at the earliest possible date.

Gypsum Plant Sold

The Certainteed Products Corporation recently bought the Turkey Creek gypsum plant in the northwestern part of Pueblo County, Colorado, from the Beaver Products Company. Gypsum will be shipped from this plant, which is 160 acres in extent, to several other plants in midwestern cities belonging to the new owners.

New Gravel Plant for Indiana

The Lick Creek Gravel Company, of Indianapolis, recently put into operation a new gravel plant at Lick Creek and Bluff road. According to officials of the plant it is modern in every way, being equipped to wash and screen the gravel into five different grades and having a storage capacity of 400 cubic yards. The plant was constructed by the Knox Engineering Company and the Page Engineering Company. E. H. Cadle is president of the company.

Bechtel-Kaiser Company Incorporates

The Bechtel-Kaiser Rock Company has been incorporated with headquarters in San Francisco. The crushing plant is in operation near Oroville, California. The capital stock of the company is $500,000. Directors are: K. K. Bechtel, Berkeley; S. D. Bechtel, T. M. Price, S. McWhorten, Paul S. Marrin, and G. G. Sherwood, all of Oakland.

New System Eliminates Dust

The Manistique Lime and Stone Company, after more than a year's experimentation, has perfected a plan for collecting the white dust, technically known as calcium hydroxide, which has heretofore escaped from the stacks of hydrators. After repeated experiments a practical system of vapor collectors which will precipitate the hydroxide has been designed.

Plans New Cement Plant

The Marquette Cement Manufacturing Company is completing plans for a new modern plant at Oglesby, Illinois. This plant will be built adjoining the present plant and will have an annual capacity of 2,000,000 barrels of cement.

To Develop Gypsum Deposit

The Mountain Gypsum Products Company of Anaconda, Montana, has been incorporated with $25,000 capital. The company owns the large deposits of gypsum near Lima, formerly owned by Dr. L. C. Ford who is one of the incorporators. At present, the company will start operations for mining and crushing agricultural gypsum, but, as equipment is installed, it will furnish all grades of wall plaster, plaster of Paris, gypsum board, partition and tile.

National Gypsum Company Plans Expansion

The National Gypsum Company of National City, Michigan plans to expend half a million dollars in the near future in expanding its plant at that city, according to an announcement made by Herman N. Butler of East Tawas, a representative of the company. This will increase the daily output of the plant to 500 tons of plaster and 300,000 feet of plaster board, and will permit the manufacture of insulating material, tile, and wall board.

New Sand and Gravel Pit for Texas

The West Point Company, sand and gravel producers of West Point, Texas, has secured an option on a large tract of land in Colorado county, near Ramsey's Point, where a large gravel deposit is said to exist, according to J. S. Edmundson, president of the company. A modern plant will be built and operated on this property. The Farrar Lumber Company of Houston has been appointed sales agent for the West Point Company and will be agent for the new plant.

Nims Speaks on Cement

Charles B. Nims of the Portland Cement Association spoke at a meeting of the Lane County Registered Engineer's Association recently held at the University of Oregon. Mr. Nims discussed the new developments in the use of cement in building and engineering work.

New Sand and Gravel Pit for Silver Lake, Indiana

Mr. Grossnickle, of North Manchester, has begun operations on a gravel pit in the northern part of Silver Lake, Indiana. If present plans materialize, the state will use this gravel on local highways.

Gravel Plant Moves Office

The Janesville Sand and Gravel Company, of Janesville, Wisconsin, recently moved its office from the old quarters at 507-509 Jackman Building to its new office building near the plant on Harding Street.

Recent Patents

The following patents of interest to readers of this journal recently were issued from the United States Patent Office. Copies thereof may be obtained from E. E. Burnham, patent and trade-mark attorney, Continental Trust Building, Washington, D. C., at the rate of 20c each. State number of patent and name of inventor when ordering.

1,665,518. Rotary discharge-chute. George E. Webb, Milwaukee, Wis., assignor to Koehring Co., same place.

1,665,519. Concrete-mixing machine. George E. Webb, Milwaukee, Wis., assignor to Koehring Co., same place.

1,665,565. Cement loading, controlling, measuring, and counting apparatus for concrete-mixers. John F. Robb, Cleveland Heights, Ohio, assignor to Koehring Co., Milwaukee, Wis.

1,664,184. Excavating and conveying apparatus. Joseph L. R. Potter, Indianapolis, Ind.

1,664,359. Excavating-bucket. Albert Grout, Sault Ste. Marie, Mich.

1,664,383. Mining-machine. Preston Upham, Boston, Mass., assignor to Sullivan Machinery Co.

1,664,384. Mining apparatus. Morris P. Holmes, Claremont, N. H., assignor to Sullivan Machinery Co.

1,664,385. Mining apparatus. Morris P. Holmes, Claremont, N. H., assignor to Sullivan Machinery Co.

1,664,386. Mining apparatus. Morris P. Holmes, Claremont, N. H., assignor to Sullivan Machinery Co.

1,664,387. Mining-machine. Charles F. Osgood, Claremont, N. H., assignor to Sullivan Machinery Co.

1,664,388. Mining-machine. Charles F. Osgood, Claremont, N. H., assignor to Sullivan Machinery Co.

1,664,598. Plastic hydrated lime and process of making it. Hippolyt Dittlinger, New Brunfels, Tex.

1,664,666. Mining-machine. Charles E. Davis, Chicago, Ill., assignor to Goodman Mfg. Co., same place.

1,664,703. Mining-machine. Thomas E. Pray, Chicago, Ill., assignor to Goodman Mfg. Co., same place.

1,664,877. Single-roll crusher. Mahlon E. First, Lakewood, Ohio, assignor to C. O. Bartlett & Snow Co., Cleveland, Ohio.

1,664,940 Excavating-shovel. John W. Page, Chicago, Ill.

1,665,050. Water, power, and speed control mechanism for concrete-mixing and similar machines. Charles F. Ball, Milwaukee, Wis., assignor to Chain Belt Co., same place.

1,665,228. Method of driving composite piles. Herman R. Smith, Douglastown, N. Y., assignor to Raymond Concrete Pile Co., New York, N. Y.

1,665,314. Water-introducing means for concrete-mixers. Erich H. Lichtenberg and George E. Webb, Milwaukee, Wis., assignors to Koehring Co., same place.

1,665,378. Power shovel. Ernest E. Peterson, Carson Lake, Minn.

1,665,390. Mine-car. Victor Willoughby, Ridgewood, N. J., assignor to American Car & Foundry Co., New York, N. Y.

1,665,517. Discharge mechanism for concrete-mixers. George E. Webb, Milwaukee, Wis., assignor to Koehring Co., same place.

High Temperature Cement Subject of Bulletin

The General Refractories Company is distributing a 20 page illustrated bulletin describing its Grefco high temperature chrome cement. Illustrations are given and results of tests shown, giving the acid and heat resisting qualities of this cement. Chief among its advantages are claimed to be its resistance to decomposition, shrinkage, and slag attack, and its holding of bond through all temperatures. A tensile strength of 325 pounds per square inch, equal to that of Portland cement, is claimed after drying or firing to any temperature. A list of uses to which this cement can be put is given for non-ferrous metal plants, boiler plants, and cement and lime plants.

International Markets New Cement

The International Cement Corporation, manufacturer of Lone Star cement, is distributing a ten page illustrated pamphlet announcing Incor high early strength Portland cement. This cement, it is claimed is made with no admixtures of any kind, is used and handled in every way like ordinary Portland cement but provides concrete that can be opened to use in 24 hours. Its workability is said to be in no way affected by its quick setting properties. A list of the different kinds of concrete work in which the use of this cement will save time and money, and why it will do so, is given along with a number of specific instances in which it is claimed to have done so.

Asbestos in 1927

The total quantity of asbestos sold or used by producers in the United States in 1927 was 2,986 short tons, valued at $338,066, according to figures compiled by the United States Bureau of Mines, Department of Commerce, from individual reports furnished by producers. These figures represent chrysotile asbestos mined in Arizona, and amphibole asbestos mined in Georgia and Maryland. The sales of chrysotile asbestos were much larger both in quantity and value than those of 1926, and the sales of amphibole asbestos showed an increase in quantity but a decrease in value.

The figures on asbestos sold or used by producers in Georgia, Maryland, and Washington were collected in cooperation with the State Geological Surveys.

Imports of unmanufactured asbestos for consumption amounted in 1927 to 223,693 short tons, valued at $8,150,340, and the exports were 309 short tons, valued at $48,774. Corresponding figures for 1926 were: imports, 257,621 short tons, valued at $8,142,505; exports, 1,104 short tons, valued at $85,922.

New Incorporations

Associated Rock Co., Los Angeles, Calif., c/o John B. Haas, California Bldg. $500,000. H. W. Jones, George H. Grabe, Edward Schlee.

Lone Star Cement Co. of Pa., c/o Chadburne, Stanchfield & Levy, Esqs., Mr. Brophy, 120 Broadway, New York City. 100,000 shares com.

Texas Silica Co., Houston, Tex. $24,000. Frank Cavenagh, West Bldg.

Independent Gravel Co., 940 Wabash Ave., Terre Haute, Ind. $10,000. Emma K. Loyd, Lambert J. Loyd, Ralph R. Pennington.

Clearwater Lime Products Co., Orofino, Ida. $500,000.

Manitoba Marble Quarries, Ltd., Winnipeg, Man. 2,000,000 shares n. p. v.

Credit Valley Quarries, Ltd., Toronto, Ont. $50,000. To quarry stone.

Muskego Washed Sand & Gravel Co., Muskego, Wis. To quarry stone, sand and gravel. 100 shares, $100 each. H. Divvert, W. Stein, F. Petroske.

Super Cement Co., Wilmington, Del. 2,000 shares n. p. v. R. L. Spurgeon, Wilmington, Del. J. V. Pumm, E. M. MacFarland, Philadelphia, Pa.

Cement Safety Discussions

W. A. Turnbach, service supervisor of the Hercules Powder Company, at Hazleton, Pennsylvania, will address the regional meeting of the Portland Cement Association, at Phillipsburg, Pennsylvania, on May 25th. On June 15th the Portland Cement Association's regional meeting at Washington, D. C., will be addressed by Theodore Marvin, managing editor of The Explosives Engineer, on the subject of safety.

Talc Production in 1927

The total quantity of talc sold by producers in the United States in 1927 was 192,316 short tons, valued at $2,234,724, according to figures compiled by the United States Bureau of Mines, Department of Commerce, from individual reports furnished by producers. The figures comprise 5,706 tons of crude talc, valued at $25,365; 1,494 tons of sawed and manufactured talc, valued at $111,650, and 185,116 tons of ground talc, valued $2,097,709. Both total quantity and value increased 6 per cent as compared with 1926. There were 20 producers of talc in 1927, as compared with 22 in 1926.

Of the total quantity sold New York supplied 94,553 tons, valued at $1,191,453, as compared with 83,231 tons, valued at $1,030,075, in 1926; Vermont supplied 54,688 tons, valued at $503,716, as compared with 53,510 tons, valued at $514,527, in 1926; and California supplied 15,760 tons, valued at $238,755, as compared with 15,419 tons, valued at $233,292, in 1926. The remainder of the output was produced by Georgia, Maryland, New Jersey, North Carolina, Pennsylvania, and Virginia.

Figures for Georgia, Maryland, New Jersey, New York, North Carolina, and Virginia were collected in cooperation with the respective State Geological Surveys.

Imports of talc for consumption in 1927 were 25,194 short tons, valued at $550,382. Corresponding figures for 1926 were 23,841 tons, valued at $540,082.

International Buys Phoenix and Warrior Cement Plants

The International Cement Corporation, whose executive offices are at 342 Madison Avenue, New York City, has purchased the Phoenix Portland Cement Company, with a plant at Nazareth, Pennsylvania, and the Warrior Cement Corporation, with a plant at Demopolis, Alabama. The Nazareth plant will be operated by the Lone Star Cement Company, a subsidiary of the International, with the principal office in Philadelphia. The Warrior plant will be operated by the Alabama Portland Cement Company, also an International subsidiary, with a plant at Birmingham. These additions bring the number of plants comprising the International system to thirteen, with a total annual productive capacity of 20,000,000 barrels.

H. Struckmann, president of the International Cement Corporation, is president of both the Alabama and Pennsylvania subsidiaries. The other officers of the Lone Star Cement Company of Pennsylvania are, C. L. Hogan, vice-president; H. H. Muehlke, secretary and treasurer; and D. S. MacBride, manager. Officers of the Alabama Portland Cement Company are: J. W. Johnston, vice-president and manager; C. C. Duff, treasurer; H. H. Muehlke, secretary; and R. M. Walker, sales manager.

Ohio Firm Incorporates

The Cincinnati Sand and Gravel Company, headed by William Reehl and Harry Donnelly, recently filed incorporation papers. The company owns 700 acres of sand and gravel land and plans are under way for a first unit of 100 car capacity. Contracts will soon be let and the plant is expected to be in operation about October 1. Distributing stations will be maintained throughout the city for the convenience of dealers.

Celite Company Acquires National Magnesia

The Celite Company of Los Angeles has purchased the plant and property of the National Magnesia Manufacturing Company at Redwood City, about 25 miles south of San Francisco. The business of the plant at Redwood City, which includes the manufacture of magnesia, asbestos and diatomaceous earth insulating materials, will be continued under the new name, National Magnesia Company.

Both of these companies started in business in 1912 and have grown steadily since then. The manufacturing plant of The Celite Company is located at White Hills, near Lompoc, California, where diatomaceous earth products such as heat insulating materials, filter-aids, admixtures for concrete, and many grades of mineral fillers are manufactured.

Arkansas Plant Enlarges

The Twin-Rivers Sand and Gravel Company of Walnut Ridge, Arkansas, owned and operated by R. F. Reeves, is enlarging its plant and making improvements in its digging and loading machinery. An 8 inch gravel pump is being installed and additional barges built increasing the capacity of the plant to nine cars daily.

Lehigh Plant Resumes

The cement plant of the Lehigh Portland Cement Company at Mason City, Iowa, has resumed operations, employing about 400 which is almost to capacity. The operations at the plant had been suspended for two months for the purpose of making some necessary repairs and expansions preliminary to the regular seasonable demand.

Operations Resumed by Cement Plant

The state cement plant at Chancellor, South Dakota, resumed production the latter part of April, according to William Fowden, plant superintendent.

Scandinavian Quarry Men Plan to Cooperate

Swedish and Norwegian stone authorities, at a recent conference in Oslo, Norway, drafted plans to promote greater cooperation between the stone industries of the two countries. No amalgamation is intended but merely a joint investigation of common problems by means of which it is believed that much unnecessary competition can be done away with, prices and transportation of material regulated, the output kept within certain limits, and the question of financing better adjusted. It is planned to establish a central depot for paving stone in Gothenburg and one for curb stone in Oslo.

Since the war the Swedish stone industry, which employs about 17,000 workmen, has suffered from lack of capital, intense domestic and foreign competition, and labor troubles. The exportations which in 1925 amounted to 848648 tons of paving stone and 69,623 tons of curb stone, dropped in 1926 to 396,448 and 54,259 tons respectively.

Sweden exported large quantities of stone to Germany before the war, but the resumption of this trade has been retarded by restrictions and duties and the subsidizing of German quarries. Exports to Belgium have been insignificant in recent years but the shipping of Swedish stone to Great Britain, France, Denmark, and Holland has increased. Considerable quantities have also been sent from Norway to Great Britain.

Sweden, in addition to granite, which is quarried for paving purposes, produces many other grades of stone. A valuable marble quarry was recently discovered in the province of Nerke and a company has been formed to exploit the find. The government bureau of standards examined samples of the stone and found them to be of extremely high quality.

New Association to Promote Sale of Indiana Limestone

The Indiana Cut Stone Association of Bloomington, Indiana, is a new concern formed for the purpose of furthering the sales of Indiana limestone. This association, which is affiliated with the Stone Institute of Chicago, plans a $500,000 advertising campaign for the Hoosier product.

NEWS OF EQUIPMENT MANUFACTURERS

New Automatic Spark Control

One of the many new features that the Climax Engineering Company is incorporating on its heavy duty industrial engines is a new automatic spark control, which functions on an entirely different principle from the centrifugal governor type. It operates from the suction in the intake manifold. With this automatic spark control, the fuel consumption decreases to a point where a saving of 10 per cent on fuel is attained on intermittent loads. It can be installed in the field on any Climax engine.

A. L. Broomall

A. L. Broomall, aged 44 years, Manager of the Renewal Parts Engineering Department of the Westinghouse Electric & Manufacturing Company, died at 11:40 o'clock Tuesday morning, April 10, in his home, 814 Mifflin Avenue, Wilkinsburg, from pneumonia. Mr. Broomall was born June 27, 1884, in Lenni, Delaware County, Pennsylvania, and was educated at the Westchester State Normal School and Lehigh University, graduating in 1906 with the degree of Bachelor of Science in Electrical Engineering. Immediately after graduation he entered the graduate students' course of the Westinghouse Company. His first important work was on the installation of the first electric locomotives on the New York, New Haven and Hartford Railroad. From 1911 to 1915 he had charge of the design of electrical vehicle motors. He was appointed section head of the direct current motor section in 1915. In 1922, he was transferred to the renewal parts engineering department as engineer in charge, later becoming manager of the department, which position he held when he died.

Combustion Engineering Elects Officers

George E. Learnard, president of the International Combustion Engineering Corporation has announced the resignation of Joseph V. Santry as president of Combustion Engineering Corporation, an American subsidiary of International Combustion Engineering Corporation, and the election of H. D. Savage as president. Mr. Savage brings to this office a long and varied experience in the manufacture of pulverized fuel burning equipment and is a recognized authority. Prior to his entry into that field, he was the active head of the Ashland Fire Brick Company and he participated in the organization of the Refractory Manufacturers' Association serving as its first president. In 1914 he became vice-president of the American Arch Company and, two years later, vice-president of the Locomotive Pulverized Fuel Company. When the Combustion Engineering Corporation purchased the Lopulco Pulverized Fuel Systems in 1920, Mr. Savage became associated with this organization as the directing head of the Pulverized Fuel Division.

At that time, George T. Ladd was elected vice-chairman of the board of directors of the Combustion Engineering Corporation. Mr. Ladd is an authority in the design and manufacture of steam boilers, and has achieved success in this field, especially in connection with large units such as those installed at the Fordson plant of the Ford Motor Company, the Kip's Bay Station of the New York Steam Corporation, and a number of prominent stations abroad.

Compressors and Vacuum Pumps Fully Discussed

The Ingersoll Rand Company is distributing its illustrated 42 page catalog, form number 3150, which discusses air compressors, gas compressors, and vacuum pumps of the straight line type of medium size. The company builds more than 1,000 sizes of which ER and FR types, with which the catalog is concerned, are largely predominant.

Many of the illustrations, which are accompanied by discussions, are devoted to different successful installations and the duties performed. Cuts of the different sections of the machines show, among other things, the removable stuffing boxes; valve chambers and their ready accessibility; the assembled valve plate; the simple disc valve of special steel; assembled valve plate, method of holding valve plate in cylinder barrel; the two sets of air and steam pistons; crosshead, crosshead pin and end of piston rod; forged steel connecting rods; forged steel crankshaft; large direct steam passage of cylinder; and the balanced piston steam valve.

A Double Purpose Torch

The Milburn combination cutting and welding torch type T1 is announced as being another step forward in speeding up welding and cutting operations and in saving labor and gases. To change from cutting to welding, it is not necessary to change the tip as a convertible feature of the tip changes it from cutting to welding or vice versa by a turn of the tip. In one position, the gases are automatically passed through the preheating gas passages while the high pressure oxygen is carried through the central hole for cutting. In the next position, made by a quarter turn of the tip, the cutting oxygen is cut off and the welding gases are conveyed through the central passage of the cutting tip, making a welding flame. The tips are constructed so that when the tip has outlived its usefulness for cutting tip, it is serviceable for welding.

Torch heads, valves, bases and other parts of bronze forgings, having a tensile strength of upwards of 5,000 pounds per square inch, cause the lightness and durability of the Milburn line which are found in the new torch. The seamless high pressure tube is drawn with triple thick walls and is of nickeled silver.

Manitowoc Takes Over Moore Speedcrane

The Moore Speed Crane will now be built and sold by the Manitowoc Engineering Works, an arrangement recently effected with the Moore Speed Crane Company, Chicago, which continues as sales representatives in Chicago for the Manitowoc Engineer Works. In New York City, the authorized sales agents for Manitowoc are Forsythe Brothers, 30 Church Street. An extensive manufacturing program on the Moore Speed Crane is planned by the Manitowoc Engineering Works, which has large scale manufacturing facilities.

Grant Increases Capital

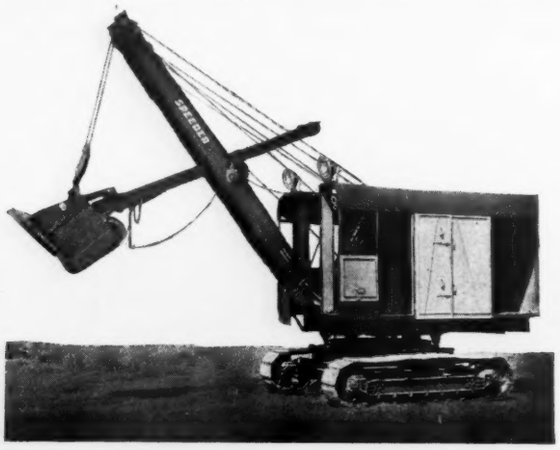
The Grant County Sand and Gravel Company of Anderson, Indiana, has recently issued an additional $20,000 in preferred capital stock. It is announced that the additional capital will be added to that appropriated for improvements to the plant.

Clark Moves Offices

The Clark Car Company announces the removal of its general and executive offices to Suite 1310 Clark Building, Pittsburgh, Pennsylvania.

New Excavator Introduced

A new model B-2 of one-half yard capacity that incorporated many improvements over the Model B-1, which no longer is in production, has been introduced by the Speeder Machinery Corporation, manufacturers of fully convertible, full revolving gasoline and electric excavators. The sliding gear used in the Model B-1 in making the change from traction to swing has been made obsolete by the introduction of a reversible jawed clutch assembly which retains all the desirable features formerly used and has the advantage of positive mesh at all times, and making all vertical



shafts removable and readily demountable, insuring unequalled ease in operation as well as long life.

A Hercules Model OX engine is used in place of the Model O used in the Model B-1, thus giving added power. Other improvements are double tread sprockets and a large turntable. There are two flood lights on the top of the cab, a dome light in the top of the cab and a spot light that is used for a trouble light. The operator can shut off his motor while waiting for trucks and start immediately by stepping on the starter button on the floor board. He operates all the controls, gas and spark levers, light switch and starter button while seated in a seat near the front of the cab.

Sprout, Waldron Increases Sales Force

David E. Smythe, formerly with the Fairbanks Morse Company; E. Harold Neely, formerly with Royersford Foundry and Machine Company and J. W. Ryan, recently with Brown and Sharp, have been added to the sales force of Sprout, Waldron and Company. This company, which recently purchased the transmission business of the Valley Iron Works, has been steadily growing and increasing its sales and engineering departments.

Consolidated Products Moves to Larger Quarters

The Consolidated Products Company, which handles used chemical machinery, has outgrown the present quarters on the 14th floor and is moving to an entire wing of the 16th floor of 15 Park Row, New York City, with twice the office facilities. In 1927, this company found it necessary to increase the size of the machine shops at Newark, New Jersey. This followed from the adoption of a policy of overhauling and rebuilding machinery before shipment, bringing a higher standard of quality in the used chemical machinery field.

Discusses Owen Buckets

The Owen Bucket Company is distributing a sixteen page illustrated catalog giving a brief description of the various types of clamshell buckets it manufactures and a set of tables giving their dimensions, ratings, and weights. These buckets are said to have many exclusive patented features, chief among which are concentration of weight, low in the construction, a one-piece crosshead with minimum number of parts, complete protection and lubrication of the main shaft bearings, and long life sheaves and cables. Types and sizes are made for all classes of work and for every size and make of crane.

Convertible Shovel Featured

The Ohio Power Shovel Company is distributing an illustrated bulletin describing the Lima "101" combination gasoline shovel, dragline, clamshell and trench-hoe. Remarkable performance is claimed for this machine and excerpts of letters from satisfied users are given to support these claims. Although primarily designed as a shovel it can be converted into a dragline clamshell or trench-hoe by changing the boom. Construction throughout is of the most modern design. Features of this machine are its all steel, truss reinforced boom; hoisting speed of 100 feet per minute, ability to handle loads above and beyond the point of the boom; and its travel speed of 1¾ miles per hour.

Pennsylvania Crusher Moves Chicago Office

Pennsylvania Crusher Company of Philadelphia has moved its Chicago office from the Illinois Merchants Trust Building to the new building at 333 North Michigan Avenue.

American Hoist and Derrick Appoints New Agent

The American Hoist and Derrick Company of St. Paul has appointed J. T. Seaver, Inc., Fairmont Cedar Building, Cleveland, Ohio, representative for the Cleveland district.

A Loader for Stockpiles

George H. Haiss Manufacturing Company, Inc., is distributing an 8 page catalog, 328, "A Loader for Stockpiles," which illustrates the Haiss model 16 loader. This machine was especially designed to have the proper size, capacity and power for a stock pile machine. It is recommended for loading crushed stone, sand, gravel and similar material. The rated capacity of model 16 is one cubic yard per minute for material with lumps not exceeding 6 inches and weighing not over 125 pounds per cubic foot.

The machine is equipped with 4 by 5 inch Waukesha 30 h.p. gasoline engine or a 15 h.p. electric motor to suit conditions. Transmission is enclosed with gears running in oil and fully protected. The two friction clutches are enclosed in oil and the drive is a double strand, bushed roller pin chain from the engine sprocket to the transmission. It has double creeper tread units which carry the chassis with a 3 point suspension. The elevator boom is of structural steel rigidly pivoted to A frames and raised and lowered with handwheel, operating worm gear and jack-knife levers; buckets are 12 by 16 inches with renewable toothed cutting edge; and special Haiss design feeding propellers on each side of the elevator forming a converging, interrupted screw conveyor which carries material from a seven foot face on the pile to the buckets. The creeper drive is a heavy dusty bushed roller pin chain from transmission to sprocket and pinion meshed with track sprocket and is steered by woven asbestos lined brakes on transmission differential shafts. By applying either brake, one side is retarded and the opposite side which is free turns the machine as desired.

Whitcomb Describes Heavy Gasoline Locomotives

The George D. Whitcomb Company, of Rochelle, Illinois, in its 20 page illustrated Bulletin 2824, describes the Whitcomb line of 10 to 30 ton, heavy weight, narrow gauge gasoline locomotives. These are all of the standard 4-wheel, 4-speed, gear-driven type with the various units arranged much the same as in standard automobile design. The artillery type radiator is in front, with the engine just back of it, the clutch is housed in the flywheel of the engine, with the transmission just back of it. The engine hood is similar to a truck hood and the cab at the rear is of standard locomotive design. The transmission is beneath the center of the cab with the shift, forward and reverse levers conveniently placed. The frames are 4-piece heavy cast sections, and are designed to carry the full weight of the mechanism with a large margin of safety, except in the CR4U-10 model where the frame is cast in one piece. Springs are of the semi-elliptical type and a cross-equalizer gives the locomotive a three-point suspension and keeps the rail-load in constant balance. Both Le Roi and Climax 4 and 6 cylinder engines are used, all of them of the heavy duty, industrial, 4-cycle water-cooled type, with force feed lubrication, centrifugal water pump, Bosch high tension magnetos, Leece Neville starting and lighting systems, and Stromberg carburetors. These engines can be readily adapted to the use of fuels other than gasoline. The multiple disc, cork insert clutch runs in oil and is fully encased. Pressure between discs is maintained by a heavy coil spring so designed that a slight slippage is provided to avoid any jerk when the clutch is first engaged. The transmission is of the selective gear type, providing four speeds in either direction. The shafts are of 3½ per cent nickel heat treated steel, the gears chrome Vanadium steel, specially heat treated, machined and case hardened, and the roller bearings are heavy duty Timken. The drive is transmitted from the transmission to a jack-shaft by bevel gears and to the rear axle by two 2-inch pitch roller chains. Drive from the rear to the front axle is by a single roller chain, giving a single unit four wheel drive. The locomotives are fitted with full steel cabs, the open type being standard on the 10 to 14 ton sizes, and the closed type on the 16 to 30 ton. Floor plates are so arranged that any part of the transmission is accessible without the use of a pit. Four wheel, compound lever brakes are used, wheels are of solid forged steel, and the axles of ARA specification heat treated steel.

A complete list of locomotive and engine specifications, speed and drawbar pulls, and a table for determining the size of locomotive required for any type of work, are included.

Minogue Flue Dust Feeder

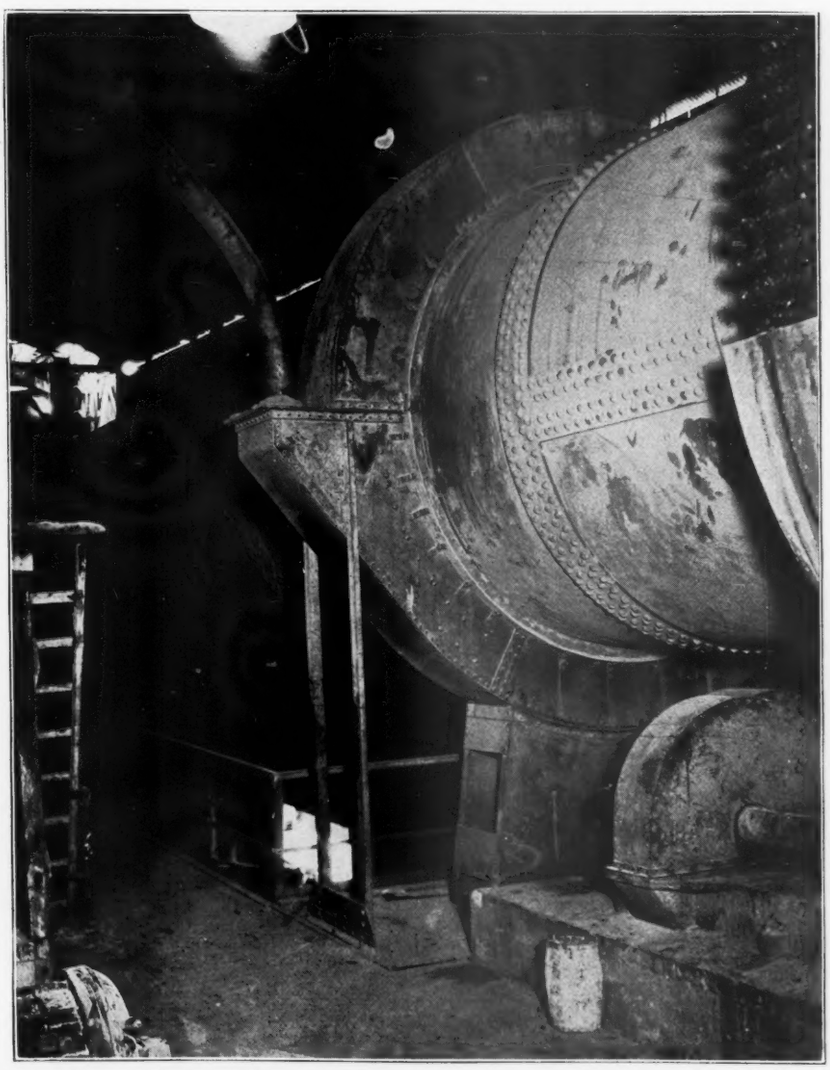
The Minogue flue dust feeder returns flue dust to a wet process rotary kiln in the dry zone of the kiln. The object is to handle the fairly large amount of flue dust collected in waste heat boilers, breechings or dust collectors to a wet process kiln without interfering with the slurry feed. Mud rings in the kiln and setting up of the slurry are eliminated.

The flue dust feed pipe is attached to the side of the kiln in the dry zone at such a point that wet slurry will never extend to the feed nozzle. This feed pipe is surrounded by a dust-tight casing which is kept filled with flue dust. The equipment furnished includes the feed piping and casing. Means of handling the dust to the casing are provided by the purchaser to suit the arrangement of the plant under consideration.

By this means a large economy is effected. Flue dust normally difficult to handle and in many instances thrown away is recovered after considerable labor and treatment has been expended on it. As it is largely cement, by feeding it into the kiln in the dry state the amount of slurry fed to the kiln is the same with or without the feeder

A report from an installation states that during a period of five months 2836 tons of flue dust were handled. This represents a total saving and increased income to the cement company of $8,779 on this amount of flue dust. This takes into account the saving in the cost of disposing of the flue dust by other means, the value of the finished cement and the labor cost of handling the flue dust by means of the Minogue flue dust feeder.

The Minogue flue dust feeder is covered by patents taken out by Mr. R. E. Minogue, Assistant Superintendent of the Manitowoc Portland Cement Company, and the unit is built by the Manitowoc Engineering Works, Manitowoc, Wisconsin.



Flue Dust Feeder Installed on Cement Kiln

Cottrell Process Described for Dust Collecting

The Western Precipitation Company, of Los Angeles, California, in a 22 page illustrated booklet, describes the Cottrell Electric Precipitators for removing suspended particles from gases. A number of photographs showing these precipitators in action and a list of applications of this process, one of which is for the removal of dust and recovery of potash from cement kiln gases, are given. It is claimed for these precipitators that they will treat with equal facility gases at 100 degrees Fahr. or 1400 degrees Fahr., and gases of either neutral or highly corrosive character.

This process, briefly described, consists of passing the gases to be cleaned between two oppositely charged electrodes, the one of smaller area called the "discharge electrode," and the larger the "collecting electrode." The collecting electrode is grounded, with the discharge electrode insulated from it and connected to a source of high potential unidirectional electricity. The suspended particles become electrically charged during the process of treatment and are driven to and deposited on the collecting electrode, while the cleaned gases pass on through the apparatus. The deposited particles are dislodged from the electrodes by means of rapping devices which deliver a sharp blow on the pipe, causing the collected material to fall into a hopper. If the material is of a liquid nature it will run down the surface of the electrodes into a sump. Different types of collecting electrodes are used, such as pipes, plates, or screens, and the gas flow may be either vertical or horizontal. Units are made in sizes capable of handling from 1000 to 50,000 or more cubic feet per minute.

Chain Belt Elects

The Chain Belt Company, recently elected Robert W. Baird, Milwaukee banker, a director to fill the vacancy caused by the death of H. O. Seymour. Directors re-elected to the board are Donald Fraser, William C. Frye, J. C. Merwin, C. R. Messinger, Clifford F. Messinger, and Edgar L. Wood. A number of other companies are owned by this firm and products manufactured are concrete mixers and pavers, conveying equipment, power transmission chains, and other material handling machinery.

American Hoist and Derrick Loses W. O. Washburn

Frank J. Johnson, senior partner and one of the founders of the American Hoist and Derrick Company, on April 30th purchased and took over the partnership interest of W. O. Washburn. The business will be continued as a corporation under the same name with the following officers: F. J. Johnson, president and treasurer, Howard S. Johnson, vice president in charge of sales, and Frederic Crosby, vice president in charge of production.

Bennington Platform Scales

The Bennington Scale Company in its 48 page illustrated catalog, number 53, presents a complete line of Bennington suspended platform scales. Descriptions and specifications are given of all models from the 600 pound capacity portable scale to the 200 ton railroad track scale. Special models such as tank, rolling mill, and counting scales are also described. Many exclusive features are claimed for these scales, the most important being the patented suspended platform.

A One Man Excavator

The Bay City Dredge Works is distributing a 12 page illustrated booklet describing the Bay City Tractor Shovel with a capacity of ⅜ cubic yard (water measure). This shovel, by making a few changes, can be converted into a ⅜ yard clamshell, 10 cubic foot dragline, 48 inch wide backfiller, or an 18, 24, or 30 inch trench scoop. The over-all width is 8 feet, height 9 feet 8 inches, length 13 feet 6 inches and weight 20,500 pounds. Power is furnished by an International McCormick-Deering gasoline engine. Propulsion is by means of crawlers 10 feet 6 inches long with 3 travel speeds up to 4 miles per hour. Timken roller bearings are used, shafting is of special high carbon or nickel steel and gears are high carbon steel, forged, double heat-treated, machine-cut, and ground. Ability to turn in its own length and utilization of the engine is a counter weight are additional features. This machine is also made for truck mounting, either with a separate power unit or with power take off from the truck motor. A number of letters and photographs from users are presented to substantiate the claims made for the machine.

A New Explosive Developed

Tests were recently conducted on a new explosive in the quarries of the Hauser Construction Company near Riverside, California. It is stated that it is far superior to any powder known, having ten times the power of ordinary dynamite. The experimental shots were made by Capt. Harry Zimmer who claims to have spent 15 years in perfecting, what he has named, "Radium Atomite" which is one of 161 inventions emanating from his laboratory. It is claimed that all noxious fumes are eliminated and that radium atomite may be subjected to almost any test without causing a premature blast. The detonating speed of the explosive is given as 2380 meters per second as the result of special investigations made by experts who came to witness the blast.

An Oil Belt Dressing

E. F. Houghton and Company, of Philadelphia, Chicago and Detroit, manufactures an adhesive belt dressing which is described in a 12 page circular. It is claimed that this dressing, which is in the form of oil, will prevent slipping, will not become gummy or sticky, will not decompose or generate free fatty acid, and will not attract vermin.

Theodore Beran Retires

The retirement of Theodore Beran, commercial vice president of the General Electric Company in charge of the New York district, as of May 1, 1928, has been announced by J. G. Barry, vice president. Mr. Beran, who was born in Springfield, Mass., was elected vice president in 1926, and had been manager of the New York district since 1903.

New Testing Sieve

The Newark Wire Cloth Company has recently developed a testing sieve which is equipped with an improved joint. It is claimed to be an improvement over the old type. An important advantage designated is that the inside corner is rounded instead of sharp. Another improvement is that all soldering is done on the outside.

When the wire cloth becomes so worn as to need replacing it can readily be done by melting the old solder off and then soldering the new piece of cloth on, which is accomplished without distorting the cloth. These sieves are made in 3, 5, 6, 8, 10 and 12 inch diameters and in accordance with United States Bureau of Standards specifications, adopted as standard by the American Society of Testing Materials in 1926.

Ohio Gravel Plant Sold

The sand and gravel plant at Seven Miles, Ohio, near Oxford, has been sold by the H. S. Coulter Company to C. C. Bartlett of Norwood for $13,560.